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FINANCIAL ANALYSIS OF POTENTIAL AGRICULTURAL DEVELOPMENT ON THE SAN JOAQUIN VALLEY WESTSIDE

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HIGHLIGHTS

As irrigation districts in the San Joaquin Valley westside area complete their distribution canals and laterals, a rapid increase in the net irrigated acreage is expected. The most rapid increase will occur in the decade 1970-1980. By 1990, net irrigated land in the westside area is expected to increase by approximately 31 percent over the 1970 acreage. Due to the large amount of double-cropping of field and vegetable crops, total harvested acres is expected to increase more rapidly than the acreage of irrigated land. Thus, the total impact of the development reflects both the "new land" effect and the "intensification" effect.

Total harvested acreage will reach a peak in the decade 1980-1990 and then decrease due to the replacement of double-cropped annual crops with perennial crops such as trees and vines. The most dramatic change in the area is an expected 20- to 25-fold increase in the acreage of trees and vines, while the acreage of vegetables is projected to increase 3- to 5-fold. Speciality crops (trees, vines, and vegetables) covered only 4 percent of the irrigated land prior to the water project, but are expected to increase to about 26 percent by 1990.

At full development, ground water pumping will have declined about 19 percent from current levels. Only 1 percent of the project water supply will go unused at full development whereas about 20 percent of the safe yield of ground water basin will go unused.

About 12 percent of the irrigable land in the study area is projected to be left undeveloped at completion of the project. Almost all of these lands will be the marginal soils which require extensive reclamation programs to bring them into production.

Assuming that irrigation districts implement their planting intentions and that speciality crop prices remain constant, the overall project water repayment capacity will just cover overall project water costs at an interest rate of 7 percent. Lowering the interest rate to 5 percent, sharply increases the ratio of payment capacity to water costs. If implementation of district intended plans cause speciality crop prices to be depressed on the order of 5 to 10 percent, overall project repayment capacity would be reduced to about 68 percent of overall project water costs.

Reallocation of the total westside speciality crop acreage to districts on the basis of their supply of high-quality soils rather than on their intended plans changes repayment capacity very little for the westside as a whole. However, it markedly alters the repayment capacity-water cost ratio in individual districts.

If speciality crop producers throughout the State would reduce their acreage sufficiently to maintain constant prices, the overall project water repayment capacity is estimated to be 89 percent of overall project water costs. This is significantly greater than the repayment capacity-water cost ratio of .68 if the districts carry out their intended plans and depressed speciality crop prices result.

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FINANCIAL ANALYSIS OF POTENTIAL AGRICULTURAL DEVELOPMENT ON THE SAN JOAQUIN VALLEY WESTSIDE

by

Yuksel Isyar,[1] Charles V. Moore,[2] and Gerald W. Dean[3]

INTRODUCTION

Large scale inter river-basin transfers of water supplies are the principal vehicle by which California's increasing urban and agricultural demands for water have been met in the past. The most recent and largest of these is the storage and transport of water from northern California to the San Joaquin Valley and southern California via the California Aqueduct. In southern California, the project water will supply municipal and industrial demands; in the San Joaquin Valley, the use will be primarily agricultural. This rapid infusion of new irrigation water supplies into the San Joaquin Valley westside is expected to cause a dramatic transformation in the nature and character of agricultural production in the region.

Thirteen irrigation districts (see Fig. 1) covering approximately 1.2 million acres of land (Table 1) will receive water from the project. In some areas, irrigation water will be available for the first time. In others, the project will supplement ground and surface sources or replace dwindling ground water sources. The firm supply of Aqueduct water is expected to make feasible the cultivation of vine and orchard crops where previously the absence or uncertainty of ground water supplies ruled out such long-term capital investments.

Water deliveries from the project were first made in 1968. Table 1 shows that prior to that time there were approximately 864,000 irrigated acres in the service area. By 1990, when the Westside is expected to be fully developed, irrigated acreage is expected to increase by 330,000 acres to a total of about 1,194,000 acres. Table 1 indicates that the major increases in irrigated acreage will be on the westside of Fresno and Kings counties (Westlands Water District) and in the Kern County districts (primarily Lost Hills, Berrenda Mesa, and Belridge on the westside and Wheeler Ridge-Maricopa at the southern end of the San Joaquin Valley).

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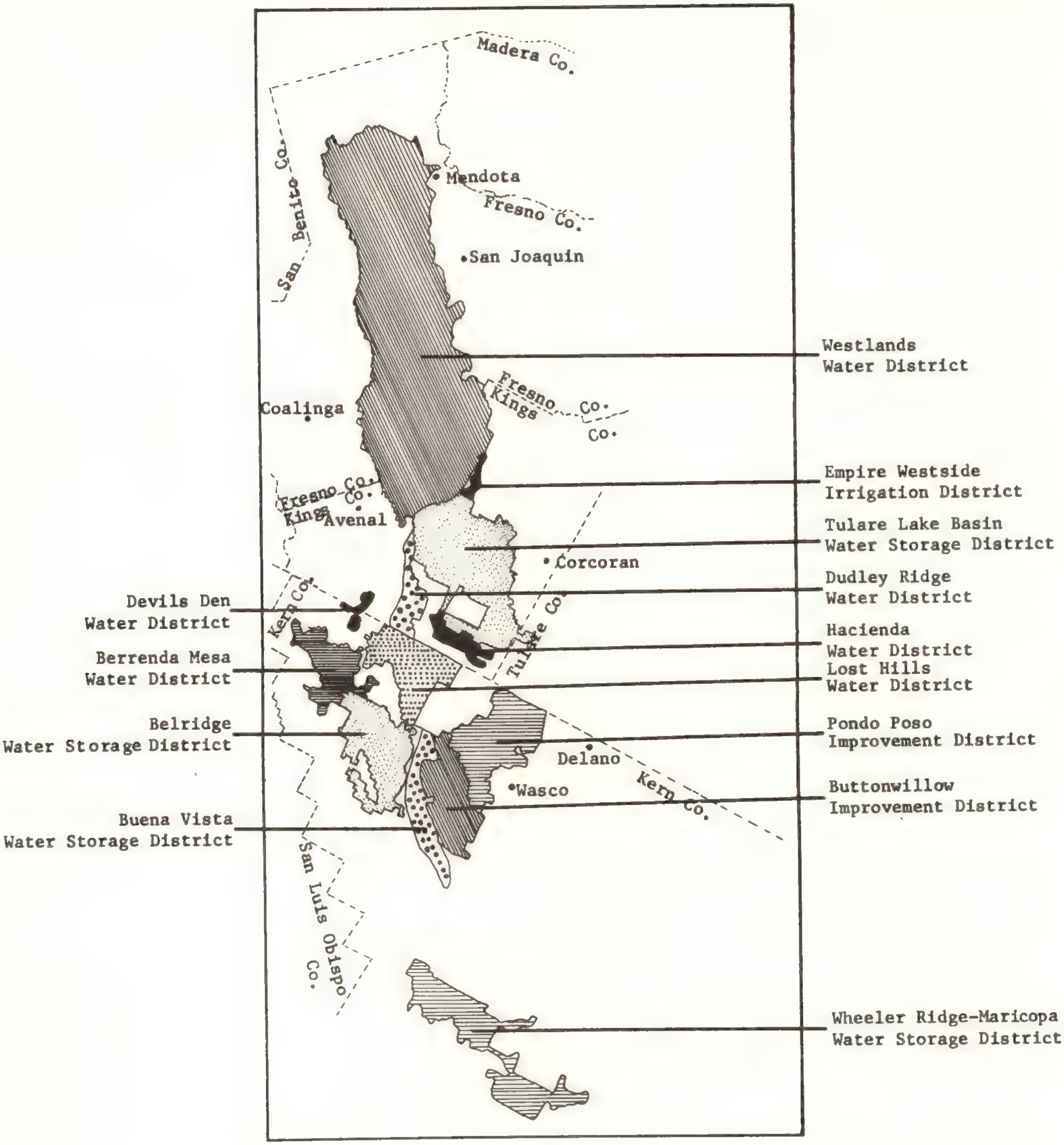
Madera Co.
Mendota
Fresno Co.
San Benito Co.
San Joaquin
Westlands Water District
Fresno Co.
Kings Co.
Coalinga
Empire Westside Irrigation District
Fresno Co.
Kings Co.
Avenal
Tulare Lake Basin Water Storage District
Corcoran
Dudley Ridge Water District
Devils Den Water District
Kern Co.
Tulare Co.
Hacienda Water District
Berrenda Mesa Water District
Lost Hills Water District
Belridge Water Storage District
Pondo Poso Improvement District
Delano
Wasco
Kern Co.
Buttonwillow Improvement District
Buena Vista Water Storage District
San Luis Obispo Co.
Wheeler Ridge-Maricopa Water Storage District

FIGURE 1. Irrigation Districts Included in Westside Study

Source: [3].

TABLE 1

Potential Effects of the California Aqueduct on Irrigated Acreage on the San Joaquin Valley Westside

Irrigation district	Irrigated acres			Added irrigated acres		Acres capable of receiving 3 acre-feet of water, all sources			Added acres capable of receiving 3 acre-feet of water	
	1968[a/]	1980	1990	1968-80	1968-90	1968	1980	1990	1968-80	1968-90
	acres									
Westlands Water District	427,000	521,000	521,000	94,000	94,000	331,000	521,000	521,000	190,000	190,000
Empire Westside Irrigation District	6,820	6,820	6,820	0	0	6,000	6,000	5,330	0	-670
Tulare Lake Basin Water Storage District	153,000	166,000	166,000	13,000	13,000	116,000	126,000	122,000	10,000	6,000
Dudley Ridge Water District	10,955	27,540	27,540	16,585	16,585	8,670	19,330	19,330	10,660	10,660
Hacienda Water District	13,920	7,850	7,850	-6,070	-6,070	4,000	9,000	8,670	5,000	4,670
Devil's Den Water District	2,900	6,470	6,470	3,570	3,570	2,670	6,330	5,670	3,660	3,000
Lost Hills Water District	12,000	41,000	54,000	29,000	42,000	10,000	36,000	47,000	26,000	37,000
Berrenda Mesa Water District	20,000	50,000	50,000	30,000	30,000	23,300	62,000	62,000	38,700	38,700
Belridge Water Storage District	12,000	60,000	74,000	48,000	62,000	8,330	41,000	54,000	32,670	45,670
Buttonwillow Improvement District	41,000	47,000	54,000	6,000	13,000	41,000	60,000	60,000	19,000	19,000
Pond-Poso Improvement District	43,000	49,000	53,000	6,000	10,000	49,000	57,670	57,670	8,670	8,670
Buena Vista Water Storage District	59,000	59,000	59,000	0	0	58,000	77,000	83,670	19,000	25,670
Wheeler Ridge-Maricopa Water Storage District	62,000	114,000	114,000	52,000	52,000	58,330	120,670	123,330	62,340	65,000
TOTAL, All Districts	863,595	1,155,680	1,193,680	292,085	330,085	716,300	1,142,000	1,169,670	425,700	453,370

a/ For some districts, acreage is for latest year available rather than 1968. For further detailed tables see [3], Tables A-1 through A-13.

Source: [3].

These two major areas differ in several respects. First, Westlands Water District will be served exclusively by federal water at a relatively low price; the Kern County districts receive State water at considerably higher prices. Second, much of Westlands Water District is already developed from high-cost underground water supplies, so that the federal water will supplement or substitute for ground water; the Kern County districts, on the other hand, are new districts receiving water for the first time and are developing large areas of new land.

The acreages of newly irrigated land indicated in Table 1, taken alone, underestimate the total impact of the water project since the new water supplements existing supplies in several districts. One method of roughly assessing the total increase in effective irrigated acreage caused by the additional water supply is to compare the acreage capable of receiving three acre-feet of water in 1968 with that in 1980 and 1990. A supply of three acre-feet of water per acre is approximately sufficient to allow an intensive cropping pattern including summer crops. Table 1 shows that the acreage capable of being intensively cropped is estimated to increase by about 454,000 acres between 1968 and 1990. These calculations of additional intensively cropped acreage take into account all sources of water supply — State and federal surface sources, other surface sources, and groundwater [3].[4/]

Transporting water for long distances (in some cases over 400 miles) and lifting it in elevation is expensive even for large volumes. Farm headgate costs for project water will range from a low of approximately $9.00 per acre-foot in Westlands Water District to a high of about $46.00 per acre-foot in one zone of the Belridge Water Storage District. Groundwater pumping costs on the Westside range from $10.00 to $22.00 per acre-foot -- also considerably higher than those experienced in most other producing areas of the State.

THE PROBLEM

The basic facilities which will serve the Westside of the San Joaquin Valley are being constructed under the California State Water Project and the Federal-State Joint Project (San Luis Unit of the Central Valley Project). Agriculture's share of reimbursible costs must be repaid from water sales and taxes on the beneficiaries -- the growers. Due to the relatively high water costs projected for the Westside, many field crops will be unprofitable.

[4/] Numbers enclosed in brackets indicate reference cited in bibliography.

Growers will therefore tend to concentrate on speciality crops such as tree fruits, nuts, grapes, and vegetables and on certain field crops for which water costs are a relatively small percentage of crop value. However, the markets for most of the speciality crops are relatively narrow and market prices are sensitive to small shifts in supplies. Furthermore, production of some of the higher value field crops already is limited by institutional controls.

The key question is whether this large inter-river-basin transfer of irrigation water will be economically and financially feasible when the impact on commodity prices of a greatly expanded irrigated land area is taken into account. Stated more positively, given the high unit water costs to Westside San Joaquin Valley irrigation districts, and given the market limitations for high-value crops, what cropping systems and development plans over time would maximize the growers' capacity to repay the water charges?

In the planning stages of the Westside project, feasibility reports for each of the 13 water districts to be served included projections of future cropping systems and estimated repayment capacity for project water. On the basis of these plans, each district signed water service contracts defining water costs, annual entitlements, and peak period deliveries. In a recent study, Dean and King [3] aggregated the projected cropping plans for the 13 districts and, on the basis of estimated supplies from other areas and prospective market demands, concluded that if these plans were carried out price declines would likely occur for the speciality crops grown. If prices decline, how seriously would this affect the financial feasibility of the Westside project? What adjustments might growers make to improve financial feasibility?

Specific Objectives of the Study

The objectives of the study are to provide answers to the following specific questions:

1. What is the estimated payment capacity for the westside districts as a whole, assuming that producers in each district carry out projected cropping plans for that district and assuming that commodity prices remain at recent average levels? How does this payment capacity compare with water costs?
2. What is the estimated payment capacity for each district assuming that it carries out its projected cropping plans, but that speciality crop prices drop to levels estimated by Dean and King [3]. How does this lower payment capacity compare with water costs?

3. Is the total speciality crop acreage too high, or is there simply a misallocation among districts? In other words, would some reallocation of the speciality crop acreage among districts on an objective basis such as soil quality rather than on relative optimism or pessimism produce a more favorable repayment capacity for the westside as a whole?
4. Suppose growers throughout the State recognize the possiblity of depressed commodity prices and respond by reducing new plantings of speciality crops sufficiently to maintain prices at recent levels. What is the estimated payment capacity for westside growers under this reduced speciality crop acreage, but with higher prices? That is, would it be in the interest of Westside growers to reduce the rate of new speciality crop plantings if growers elsewhere responded similarly?
5. Since the developmental period covers a time span of over 20 years, what effect does the discount or interest rate have on financial feasibility?

The Study Area

The study area includes the 13 irrigation districts in the San Joaquin Valley (Fig. 1) which will receive water from the California Aqueduct.

Institutions

Transfer of water from the Sacramento Valley to the Westside of the San Joaquin Valley required the cooperation and coordination of all levels of government. The Bureau of Reclamation in the U.S. Department of the Interior was the contracting agency for the Federal portion of this joint Federal-State project. Under the San Luis Unit of the Central Valley Project, water is supplied to the Westlands Water District. Being a Federally financed project, the Westlands service area falls under the "160-acre limitation" provision and receives subsidized irrigation water at relatively favorable prices. Irrigation users do not receive the same subsidy in State project areas of the Westside, with the result that water costs in the State areas are considerably higher.

The State of California, through its Department of Water Resources, is the contracting agency for the remaining 12 water districts. However, the Kern County Water Agency (KCWA) was formed to be the prime contractor with the State for those districts located in Kern County. The KCWA contract with the State, which includes defining zones of benefit outside of the agricultural service area, was approved by a referendum of Kern County voters. To the extent that revenues from nonagricultural areas will be applied toward payments to the State, the required repayments from growers in the individual districts will be reduced. KCWA in turn contracts with individual irrigation districts.

Many of the irrigation districts have, in turn, entered into firm water supply contracts with individual land owners. These contracts establish repayment terms which cover both the cost of water purchased from the State and the cost of transporting and distributing water from the California Aqueduct to farm headgates within the district. In the Westlands Water District, an additional charge of $0.50 per acre foot is levied to help pay for district-owned collection drains and the large San Luis drain. This drainage system will collect and remove from the service area irrigation return flows which are of very low quality.

Soils

The proportion of high quality soils in a water service area is a critical factor in determining the ultimate cropping pattern which may evolve. For the purposes of this study, all potentially irrigable soils were classified into one of four groups, A through D.

Soil A is the highest classification and contains those soils that are deep, well-drained, medium-textured, free from salts, exchangeable sodium and boron, and have a slope of less than 3 percent.

Soil B is similar to Soil A except that slight problems may be present with respect to salts, boron, slope and/or permeability. All crops climatically adapted can be grown except for those very sensitive to salts or boron. Yields are slightly below those on Class A soils but can be raised to the A level with a leaching program.

Soil C has moderate problems with respect to salts, boron, permeability and/or drainage. The slope cannot exceed 6 percent. It is only feasible to grow tolerant crops on these soils. Yields for adapted crops are below those on Soils A and B; however, after a reclamation program, yields can be brought up to parity with B soils. Further reclamation would not increase yields. In other words, C soil cannot be eventually converted to A soil by continued reclamation.

Soil D is a marginal soil and may contain combinations of high salts, boron, and sodium and may have drainage problems as well. With intense reclamation, it is possible to grow very tolerant crops. Yields may be brought up to equivalence with C soils only after an extended reclamation program.

A detailed breakdown of irrigated land, by soil class, is given in the upper portion of Table 2. Acreages are provided for the "current" period (1968 or most recent year for which data were available) and projected to 1990, the period of essentially "full development." Data for immediate years are available in [5] and were used in the analysis.

Water Supply and Costs

The lower portion of Table 2 shows the estimated water supply, by source, for each district, under current conditions and projected to 1990. Data for intermediate years were also estimated in [5] and were used in the analysis. The estimated water costs per acre-foot, by year and district, are shown in Table 3.

Climate

Climate is extremely important in determining crops which might be grown successfully in the study area. Researchers working on the Westside Crop Adaptability Study [8] reported the following recommendation: (1) Practically all vegetable and field crops grown in California can be grown on the Westside. (2) Most of the "hot area" grape varieties presently grown on the east side of the Central Valley will grow well in the study area. (3) Most of the deciduous tree fruits and nuts are adaptable to the climate on the Westside. However, only certain varieties of prunes and walnuts which are tolerant of mild winters and hot summers are adaptable. Doubtful crops are apples, pears, apricots, and sweet cherries.

Citrus production in the current study is limited to an area along the foothills defined by Shumway [6] as a thermal belt, where air drainage is good and frost hazard is moderate. Only five of the water districts have lands included in the thermal belt (Figure 2).

Crops

Based on their tolerance levels to salt and boron, climatic adaptability and the relative importance of their market demand in the future, 32 crops ranging from highly tolerant (of salt and boron) barley in the field crop

TABLE 2

Water Supply, by Source, and Irrigated Acres, by Soil Class, Westside Districts, Current (approximately 1968) and Projected to 1990[a]

Item	Date	Unit	Westlands Water District	Empire Westside Irrigation District	Tulare Lake Basin Water Storage District	Dudley Ridge Water District	Hacienda Water District	Devil's Den Water District	Lost Hills Water District	Berrenda Mesa Water District
Irrigated Acres										
Soil Class A	1968	acres	149,000	0	0	1,640	0	2,760	4,800	12,000
	1990	"	193,026	3	0	4,129	0	5,780	25,945	30,000
Soil Class B	1968	"	171,000	1,640	14,000	6,355	5,990	0	1,560	5,000
	1990	"	217,628	1,773	15,000	15,704	5,770	0	8,353	13,000
Soil Class C	1968	"	56,000	4,770	125,000	2,960	2,090	120	480	3,000
	1990	"	75,168	5,217	126,000	7,094	2,060	260	2,693	7,000
Soil Class D	1968	"	51,000	410	14,000	0	5,840	20	5,160	0
	1990	"	66,690	507	15,000	0	5,500	40	27,560	0
Total, all soils	1968	"	427,000	6,820	103,000	10,955	13,920	2,900	12,000	20,000
	1990	"	552,512	7,500	166,000	26,927	13,330	6,080	64,551	50,000
Agricultural Water Supply:										
Calif. State Water Project[b]	1968	1,000	0	0	0	0	0	0	0	0
	1990	ac. ft.	0	3	110	58	9	13	140	11
Federal San Luis Water Project	1968	"	193	0	0	0	0	0	0	0
	1990	"	1,180	0	0	0	0	0	0	0
Other surface sources	1968	"	0	5	171	0	11	0	0	0
	1990	"	0	5	171	0	11	0	0	0
Ground water	1968	"	800	7	124	25	6	5	0	0
	1990	"	380	7	75	25	6	6	0	0
Total water supply	1968	"	993	12	295	25	17	5	0	0
	1990	"	1,560	15	356	83	26	19	140	11

Footnotes at end of table

--Continued on next page.

Table 2 (continued)

Item	Date	Unit	Belridge Water Storage District	Button-willow Improvement District	Pond-Poso Improve-ment District	Buena Vista Water Storage District	Wheeler Ridge-Maricopa Water District	Total Westside
Irrigated Acres								
Soil Class A	1968	acres	8,000	7,000	3,000	0	51,000	239,200
	1990	"	46,949	8,688	3,853	0	86,053	404,426
Soil Class B	1968	"	4,000	18,000	18,000	18,000	0	263,545
	1990	"	26,003	23,349	23,158	20,800	7,394	377,932
Soil Class C	1968	"	0	16,000	22,000	35,000	5,000	272,420
	1990	"	1,068	22,263	26,489	41,608	41,978	341,898
Soil Class D	1968	"	0	0	0	6,000	6,000	88,430
	1990	"	0	0	0	6,934	5,575	127,806
Total, all soils	1968	"	12,000	41,000	43,000	59,000	62,000	863,595
	1990	"	74,000	54,300	53,500	69,342	114,000	1,252,062
Agricultural Water Supply:								
Calif. State Water Project[b]	1968	1,000	0	0	0	0	0	0
	1990	ac. ft.	58	10	8	67	303	790
Federal San Luis Water Project	1968	"	0	0	0	0	0	193
	1990	"	0	0	0	0	0	1,180
Other surface sources	1968	"	0	0	0	145	0	332
	1990	"	0	0	0	145	0	332
Ground water	1968	"	25	12	15	70	175	1,264
	1990	"	25	8	9	75	67	683
Total water supply	1968	"	25	12	15	215	175	1,789
	1990	"	83	18	17	287	370	2,985

[a] For greater detail see [3], Tables A-1 through A-13 and Isyar [5], Tables 5 through 29.

[b] Includes regulated surplus but not unregulated surplus supplies.

TABLE 3

Water Cost[a] per Acre-Foot by Years

District [b]	Water source	Year 1970	1971	1972-4	1975-9	1980-9	1990+
		dollars per acre-foot					
Tulare Lake Basin W.S.D.	State	11.50	12.00	12.50	12.50	12.75	14.23
	Ground	15.00	15.00	15.00	15.00	15.00	15.00
	Kings River	4.00	4.00	4.00	4.00	4.00	4.00
Buena Vista W.S.D.	State	13.00	13.00	13.00	13.00	13.00	13.00
	Ground	9.60	9.60	9.60	9.60	9.60	9.60
	Kern River	6.75	6.75	6.75	6.75	6.75	6.75
Wheeler Ridge-Maricopa W.S.D.							
Zone: I	Ground	18.40	18.40	18.40	18.40	18.40	18.40
Zone: II	State	--	27.00	27.00	28.00	30.00	33.00
Zone: III	State	--	--	35.48	36.48	38.48	41.48
Pond Poso I.D.	State	18.00	18.00	18.00	18.00	18.00	18.00
	Ground	13.40	13.40	13.40	13.40	13.40	13.40
Buttonwillow I.D.	State	20.00	20.00	20.00	20.00	20.00	20.00
	Ground	13.40	13.40	13.40	13.40	13.40	13.40
Berrenda Mesa W.D.							
Zone: I	State	26.00	26.00	26.33	28.00	33.33	36.00
Zone: II	State	--	--	34.67	34.67	39.33	43.67
Zone: III	State	--	--	--	34.67	43.25	46.17
Lost Hills W.D.							
Zone: I	State	22.39	22.39	22.50	23.92	25.07	25.07
Zone: II	State	--	--	20.00	20.00	21.00	22.33
Zone: III	State	--	--	--	--	25.30	25.93
Belridge W.S.D.							
Zone: I	State	28.27	28.00	25.88	25.88	25.88	25.88
Zone: II	State	--	--	23.00	23.00	23.00	23.00
Zone: III	State	--	--	--	36.00	36.00	36.00
Zone: IV	State	--	--	--	--	42.95	42.95

Footnotes on next page.

--Continued on next page.

Table 3 (continued)

District b/	Water source	Year 1970	1971	1972-4	1975-9	1980-9	1990+
		dollars per acre-foot					
Devil's Den W.D.	State	21.50	21.50	21.50	21.50	21.50	21.50
	Ground	12.00	12.00	12.00	12.00	12.00	12.00
Dudley Ridge W.D.	State	16.15	16.15	17.00	19.00	23.00	23.00
	Ground	22.50	22.50	22.50	22.50	22.50	22.50
Empire Westside I.D.	State	14.32	14.32	14.32	14.32	14.32	14.32
	Ground	18.00	18.00	18.00	18.00	18.00	18.00
	Kings River	4.00	4.00	4.00	4.00	4.00	4.00
Hacienda W.D.	State	18.25	18.75	18.75	18.75	19.25	20.75
	Ground	18.00	18.00	18.00	18.00	18.00	18.00
	Kings River	4.00	4.00	4.00	4.00	4.00	4.00
Westlands W.D.	Federal	9.00	9.00	10.00	13.00	14.00	14.00
	Ground	22.50	22.50	22.50	22.50	22.50	22.50

a/ Costs are per acre-foot at the farm headgate (fixed and variable costs) and represent a weighted average cost of project entitlement and regulated surpluses.

b/ Zones defined by the districts are sometimes aggregated for analytical convenience.

Sources: Interviews with district personnel; feasibility studies for districts. Ground water costs mainly from Moore, C.V., and J.H. Snyder, "Irrigation Pumping Lifts in the San Joaquin Valley," *California Agriculture*, Vol. 19, No. 10, October 1965, p. 14.

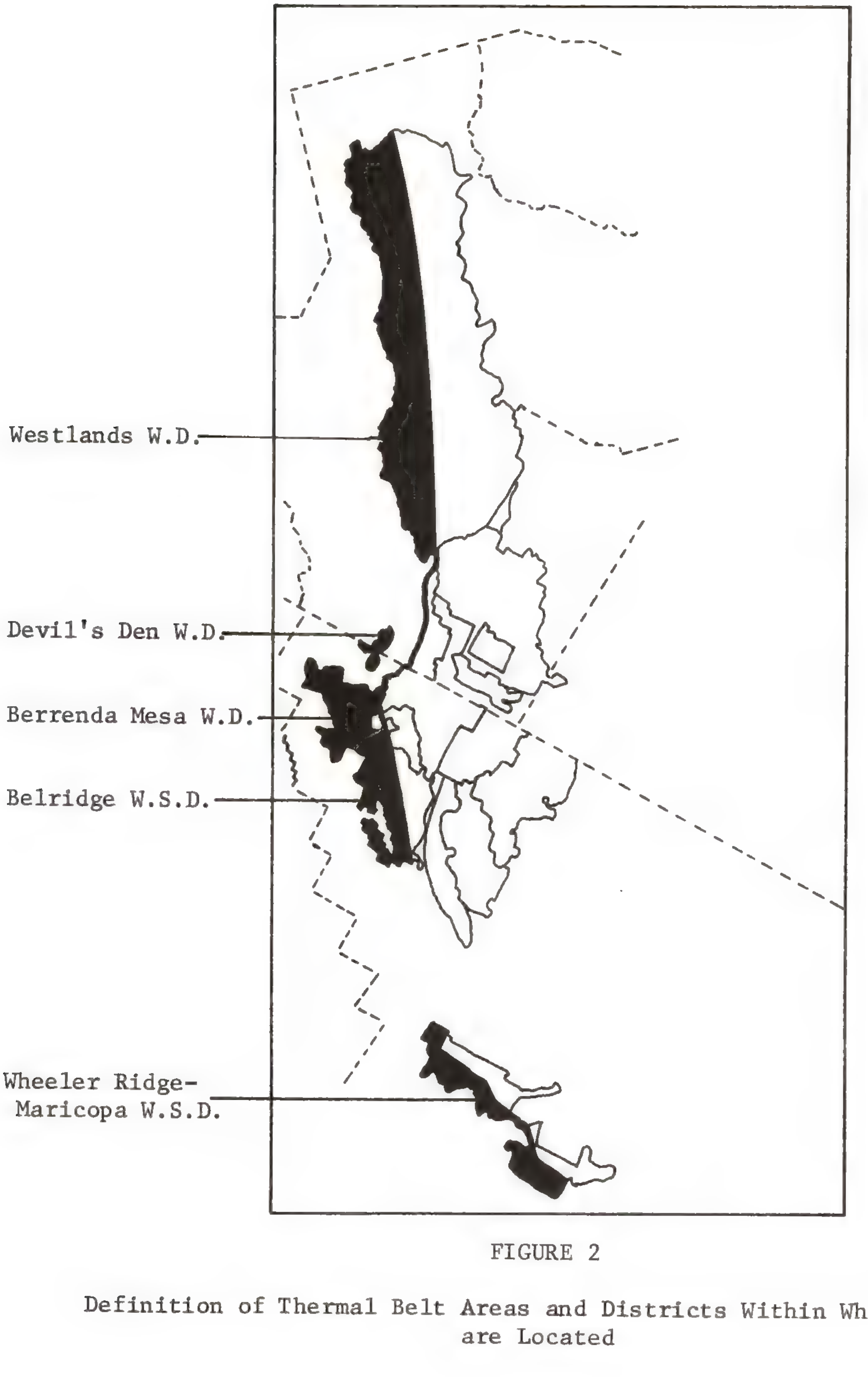

FIGURE 2

Definition of Thermal Belt Areas and Districts Within Which They are Located group to highly sensitive tree fruits such as peaches were selected for more detailed analysis. A complete list of the selected crops can be found in Table 4.

It is clear from Table 4 that a wide variation in crop sensitivity to salinity and boron occurs both within and among crop categories. In a very general way, most of the field crops are considered tolerant; the vegetables generally fall in the semi-tolerant group and almost all of the tree crops are considered sensitive. In line with this observation, the following assumptions were made concerning crop-soil adaptability. Field crops can be grown on Soils A, B, and C without a reclamation period. Vegetables can be grown on Soils A and B and tree crops can be grown only on Soil A without reclamation. Only sugar beets, wheat, milo, and barley can be grown on Soil D prior to a leaching program. Crop yields were adjusted in relation to the quality of soil on which they are grown, as shown in Table 5. Detailed crop yields are available in Appendix Tables A-1, A-2, and A-3.

FRAMEWORK OF ANALYSIS

This study posed a series of questions earlier concerning financial feasibility of alternative development plans under various assumptions as to markets, prices, and interest rates. Specifically, the objective is to estimate the maximum present value of water payment capacity for each district, given physical restraints on soil capability, contractual limits on total and peak water availability, and various market share restraints on the acreages of speciality crops. The latitude for maximization within this set of contraints is relatively limited since an important portion of the cropping pattern (the speciality crop acreage) is assumed to be predetermined according to the districts' intended plans or to market limits. However, allocation problems which remain include selecting the most profitable field crops to complete the cropping pattern, allocating the crops (including speciality crops) optimally among soil categories, and allocating water supplies optimally among crops and soils (including land reclamation) over the planning horizon.

A convenient analytical tool for solving these allocation problems within a rather complex set of restraints is the multiperiod linear programming model. (For more detail concerning these models, see Isyar, [5].) By dividing the planning horizon into discrete segments using time dated resources and activities, solutions were obtained showing the path of development through time

TABLE 4

Crops Selected for Analysis

Crop	Sensitivity to salinity and boron	Projected California acreage in 1980[a]
Field crops		
Sugar beets	Tolerant	325,100
Dry beans	Sensitive	214,700
Alfalfa seed	Semi-tolerant	160,300
Cotton	Tolerant	837,700
Corn	Semi-tolerant	193,200
Barley & Mexican wheat	Tolerant	1,266,400
Grain sorghum	Semi-tolerant	373,500
Tomatoes		
Tomatoes, processing	Semi-tolerant	160,300
Dark green & yellow		
Broccoli	Semi-tolerant	39,000
Carrots	Semi-tolerant	28,000
Peppers, bell	Semi-tolerant	7,800
Spinach	Tolerant	9,000
Other vegetables		
Asparagus	Tolerant	59,300
Beans, snap	Sensitive	12,290
Cabbage	Semi-tolerant	13,100
Cauliflower	Semi-tolerant	24,200
Corn, sweet	Semi-tolerant	19,500
Lettuce	Semi-tolerant	147,900
Peas, green	Semi-tolerant	17,740
Potatoes	Semi-tolerant	93,500
Melons		
Cantaloupes	Semi-tolerant	61,400
Honeydews	Semi-tolerant	10,100
Watermelons	Semi-tolerant	14,300
Tree nuts		
Almonds	Sensitive	280,000
Walnuts	Sensitive	225,000
Citrus fruits		
Oranges, navels	Sensitive	258,000
Oranges, Valencias	Sensitive	
Semitropical fruits		
Olives	Sensitive	39,000
Deciduous fruits		
Nectarines	Sensitive	13,000
Peaches, clingstone	Sensitive	136,000
Peaches, freestone	Sensitive	
Grapes		
Wine	Sensitive	461,000[b]

[a] Projections from [3].

[b] All uses.

TABLE 5

Index of Yields Per Acre by Soil Category

Type of crop	Soil A	Soil B	Soil C	Soil D
Field crops	100 percent	100 percent	90 percent before reclaimed, 100 percent after	75 percent[a/] before reclaimed 90 percent after
Vegetables	100 percent	90 percent before reclaimed, 100 percent after	Do not plant before reclaimed	Do not plant
Trees	100 percent	Do not plant during 1-3 years of reclamation, then 100 percent	Do not plant	Do not plant
Vines	100 percent	Do not plant during 1-3 years of reclamation, then 100 percent	Do not plant	Do not plant

Source: Carter et al. [1], p. 19, Table 5 plus minor adjustments by authors.

[a/] Only sugar beets, wheat, milo, and barley are permitted to be grown on this soil before reclaiming it into better quality soil.

which maximizes the present value of payment capacity for water. For this study, the planning horizon was divided into six segments or time blocks, 1970, 1971, 1972-74, 1975-79, 1980-89, and 1990 and beyond. Additional time blocks could have been defined but this would have increased computational cost with little increase in accuracy.

Objective Function and Present Value Calculation

The objective of the linear programming models is to determine the cropping pattern which will maximize the economic returns to land and management resources on the Westside, subject to the limits imposed by the price of water, the availability of irrigation water, the availability of soils of different qualities, and the demand for the products of the project. Land and management are the residual claimants to the income generated by a transfer of water to the Westside. These two inputs must also absorb any loss which might be incurred since the land is pledged as collateral for repayment of project costs. For a given water price, the linear programming solution which maximizes the return to these two inputs also maximizes the repayment capacity of the project for irrigation water.

In order to make direct comparisons of income received or costs incurred in one time block with those from another time block, all incomes, and expenses were discounted to their 1970 value. For example, at an interest rate of 7 percent, a dollar received in 1985 is worth only $0.362 in 1970 and a dollar received in 1990 is worth only $0.258 in 1970. A dollar received in 1985 is worth $0.481 in 1970 when discounted at an interest rate of 5 percent. In other words, the farther in the future the time block under consideration, or the higher the discount rate, the lower the present value of the future sum.

The present value of future income and cost streams is calculated as follows:

$$PV = \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + \ . \ . \ . + \frac{R_n}{(1+r)^n}$$

where PV is the present value, R_n is the income or cost in the n^{th} year, and r is the discount rate or interest rate.

The annual income of perennial crops such as tree fruits, nuts, and grapes varies each year due to the developmental period between the planting year and the age at which they reach full bearing. Therefore, estimates of the present value of future net incomes from perennial crops were converted to level value annuities which placed them on the same basis as annual crops in the linear programming model. For analytical convenience, discounting over an infinite horizon was used.

In summary, the objective function of the linear programming model was to maximize the present value of the stream of returns to land and management over an infinite planning horizon. The results were then used to estimate the payment capacity for water by assigning market prices to land and management, correcting the objective function value for the cost of water included, and assuming that the residual income is available to pay for project water.

Constraints in the Models

The linear programming models include physical constraints on land and water supply, institutional restraints such as cotton allotments, and cropping pattern restraints. These constraints are described briefly below.

Land and water supplies.--The supply of land available in each district is obviously a restraint. A separate restraint is required on the acreage of each soil type (A through D) available in each time period. These restraints at full development (1990) were shown earlier in Table 2. Intermediate year restraints are given in [5]. The levels of these restraints may change over time (from one time block to another) as the district provides water service to new zones within the district. Also, reclamation activities can change the proportion of soils in the district by converting soil from one class to another through leaching and the addition of soil amendments.

Water supplies can be limiting either in total annual supply, or in a critical peak period. Each district receives a basic annual entitlement of water specified in the contract between that district and the water agency, plus an estimated amount of regulated surplus. Adding this quantity to other supplies available to growers in a district (pumping, local rivers, aand purchases from other districts), the annual total water supply to the district is obtained. This becomes the upper limit of firm water supply and is included as a constraint in each time block of the model. Table 2 provides estimates of the total water supply by district in 1968 and at full development in 1990. Intermediate year estimates are available in [5].

In addition to the annual water supply restriction, water use during the peak season is also restricted by contractual agreement. The State contracts with water agencies explicitly specify that only 18 percent of the total annual project supply may be used during any given month due to capacity limitations of the California Aqueduct. For districts having ground water supplies available, it was assumed that an upper limit of 30 percent of the estimated safe yield could be pumped in any one month of the growing season. Since the highest consumptive use of water for crops grown on the Westside occurs during the two summer months of July and August, a peak water restriction for this two-month period was introduced as a restriction in each time block of the programming models.

Cotton Allotment Constraint

Since the early 1950's, the acreage of cotton in the U.S. has been continuously subject to Federal programs. Cotton allotment acreage has been allocated among states, counties, and individual farms on an historical basis during this time. Allotments can be transferred within counties with little difficulty, but transfers between counties in California require a referendum of growers in the county releasing the allotment. Since some of the irrigation districts are receiving water for the first time under the project, they have no history of cotton production or allotments. For cotton to be grown under the government program in these districts, cotton allotments must be transferred from older producing areas, mainly from within their respective counties.

The program for allocating cotton acreage and setting price supports has changed periodically by Congress and it is obviously not possible to predict changes which might occur over the entire planning horizon of this report. Therefore, certain assumptions were necessary concerning future cotton acreage and prices. Dean et al. [2] project a slight increase in the acreage of cotton in California between 1970 and 2000. However, they caution that although the U.S. has always been the world's leading cotton exporter, exports in recent years have been falling as mills in Britain and elsewhere have turned more largely to synthetic fibers. Substitution of synthetics for cotton is also evident in the domestic market.

Maximum acreages for cotton in each district were estimated by taking the existing percent of cropland planted to cotton and assuming that a maximum of 30 percent of any newly developed land could be planted to cotton.

The additional cotton acreage would be made possible through a transfer of allotments or by growing export cotton as has occurred in some recent years.

The price level for cotton was set at a lint price of 32 cents per pound starting in 1970 (approximately the current level) and was decreased one cent per pound each year until 1976. Prices were held constant at 26 cents for the remainder of the planning period (a price about half way between the current support price and the world market price). The lower prices for cotton reflect the judgment that (1) government programs are likely to move away from high price supports and toward world market prices in the decade ahead, and (2) that some mix of high-priced government program cotton and low-priced export cotton will be grown.

Cropping pattern and market share restraints.--To answer the questions posed earlier, three alternative sets of cropping patterns are examined in the study: (1) Actual district cropping plans (modified by recent experience); (2) Market shares of speciality crops based on each district's endowment of top quality soils; and (3) Reduced market shares for speciality crops (recognizing the possible need to cut speciality crop acreage to prevent price declines). These three alternatives are described in more detail below.

Actual district cropping plans were obtained from published feasibility studies for each of the 13 Westside districts. The aggregate of these projections (Dean and King, [3, Table 20]) shows an increase of 286,000 acres of speciality crops by the end of the development period (1990) beyond the approximately 40,000 acres of these crops grown in 1968. This total of 326,000 acreages of speciality crops was broken down into detailed crop categories based on the judgment of planners at that time. Recent plantings and changing market situations suggest that the mix of speciality crops actually planted will be considerably different from that originally planned. Yet, high water prices are likely to encourage about the same overall acreage of speciality crops as was planned. Based on recent trends and judgment, the authors have reallocated the total planned 326,000 acres of speciality crops in 1990 into crop categories as follows: 64 percent to perennial crops such as fruits, nuts, and grapes, and 36 percent to vegetables. The perennial crop category was further subdivided into deciduous fruit, 28 percent; tree nuts, 28 percent; grapes 19 percent; and oranges 25 percent. (The orange acreage was allocated to districts with thermal belts on the basis of the proportions of class A soils found within the thermal area.) The aggregate vegetable acreage was divided into 8 percent cantaloupes, 17 percent early spring potatoes, and 75 percent other vegetables.[5/]

The original plans made by districts were somewhat arbitrary in the sense that the proportion of high-value crops grown in a district was not necessarily directly related to market demand or to that district's supply of top quality soils. Instead, the acreage of high-value crops appeared to be primarily dependent on water prices and the need for high income crops to overcome high water costs. While high water costs will undoubtedly encourage more high-value crops, the availability of high-quality soil resources is also an important factor in plantings of crops sensitive to salt and boron.

Thus, a second cropping pattern was tested in which market shares of speciality crops for each district were based on that district's relative proportion of top quality soils. The starting point for this calculation is the increase in State acreage of speciality crops projected by Dean and King [3]. Within the State there was projected to be a continued shift of speciality crops to the Central Valley. On the basis of the State projections and these shifts within the State, the net additional acreages of tree fruits, nuts and grapes, and vegetables were projected for the Central Valley.

Under this market share model, it was assumed that each Westside district would share in the increase in speciality crop production in the Central Valley on the basis of that district's proportion of the remaining high-quality land adapted to speciality crop production in the Central Valley. Shumway [6] has estimated that there will exist about 3 million acres of top quality land well adapted to orchard and vegetable production in the Central Valley in 1980, after taking account of urban expansion, semi-public and other nonagricultural uses of land. Of this land suitable for speciality crops, about 1 million acres are already taken up by these crops, leaving about 2 million acres remaining for expansion. The Westside districts are estimated to contain approximately 38 percent of this total (the sum of A + B soils in Table 2, or about 750,000 acres). Therefore, the Westside districts are allocated about 38 percent of the net additional increase of speciality crops projected for the

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[5/] This allocation of acreage among crops closely follows the allocation in [3], Table 23.

Central Valley. At full development (1990) this means that the Westside districts have a "limit" of about 192,000 acres of tree fruits, nuts and grapes, and 132,000 acres of vegetables -- about 324,000 acres of speciality crops in total, or approximately the same as the 326,000 acres under actual district plans.[6/] However, there are substantial reallocations of this acreage among districts, resulting in a reduction of the speciality crop acreage in those districts that planned speciality crop acreages disproportionate to soil resources and increases in speciality crop acreages in districts that were more conservative in their plans.

Reduced market shares for speciality crops in each district was considered as a starting point for a third cropping pattern. The study by Dean and King [3] suggests that depressed prices for speciality crops may occur if the Westside growers carry out intended plans and growers in other areas of the State continue to expand speciality crop acreage along the lines of historical trends. Thus, the reduced market share model is suggested by the question: What would be the effect on project feasibility if growers throughout the State, including the Westside, reduced the speciality crop acreage to a level that would maintain commodity prices at an average of the period 1962-68?

Table 6 indicates the State acreage projected for speciality crops, the State acreage "required" at constant prices, and the State "excess" acres for 1980 and 1990; i.e., acreage planted beyond "requirements" at constant prices [3]. It can be expected that speciality crop producers would respond to falling commodity prices by voluntarily cutting back on crop acreage or perhaps that marketing orders would be imposed to prevent seriously depressed prices. As a simple first approximation, suppose that a proportionate reduction from planned speciality crop acreage occurred throughout the State. Table 6 shows that the percentages of "excess" acreage are 5.5 percent in 1980, and 9.0 percent in 1990. Expressed alternatively, in this market model, the projected speciality crop acreage on the Westside was reduced by 5.2 percent in 1980 and 8.3 percent in 1990 in order to maintain prices at their recent historical levels. Market shares of this reduced total Westside acreage were allocated to individual districts on the basis of each district's projected cropping plans.

[6/] Table 8, which later reports the results of Model II, gives a total of only about 318,000 acres of speciality crops. The explanation is that the market share restrictions were not completely filled in every district due to soil and water limitations.

TABLE 6

Comparison of Projected Acreages of Specialty Crops with Acreages "Required" at Constant Prices

Region	1980			1990
	Tree fruits, nuts, and grapes	Vegetables	Total tree fruits, nuts grapes, and vegetables	Tree fruits, nuts, grapes, and vegetables
	acres			
North Coast	15,000	--	15,000	17,000
Central Coast	145,000	225,000	370,000	320,000
South Coast	120,000	100,000	220,000	170,000
Sacramento Valley	310,000	70,000	380,000	460,000
San Joaquin Delta	310,000	160,000	470,000	455,000
San Joaquin Valley (nonWestside)	880,000	170,000	1,050,000	1,255,000
San Joaquin Valley (Westside)[a/]	65,000	108,000	173,000	286,000
Desert	20,000	70,000	90,000	70,000
Intermediate Elevation Valleys	24,000	—	24,000	16,000
State acreage projected	1,889,000	903,000	2,792,000	3,049,000
State acreage "required"	1,813,000	833,000	2,646,000	2,796,000
State "excess acres"	76,000	70,000	146,000	253,000
Percent "excess acres"			5.5	9.0
Percent reduction from projection to maintain constant prices			5.2	8.3

[a/] Acreage beyond 1968 levels; 1968 levels included with nonWestside acreage.

Source: Dean and King [3], modified to include potatoes in the vegetable acreage.

Prices and Production Costs

The projected product prices used in the basic analysis of this study are the county averages between 1962 and 1968 (except for processing tomatoes, oranges, and wine grapes, for which recent conditions suggested that the 1962-68 average price would be inappropriate). These basic prices are summarized in Appendix Table A-4, and more detail is available in Isyar [5].

Relatively high water costs require a large proportion of high-valued speciality crops to be included in project plans. The decision of an individual grower, or even of all growers within a small irrigation project, to plant additional acreages of a speciality crop would not significantly influence the prices received for these commodities. But in a project with a potential of adding the equivalent of almost 0.5 million acres of intensively-cultivated irrigated land, the possible impact of new plantings on prices cannot be ignored. Hoyle and Harrison [4], for example, point out that there is "far more excellent soil suitable for high value crop production in the Westside areas at this time than the market could absorb".

Dean and King [3] conclude that if their projections are accurate "most of the speciality crop acreage on the Westside will act to depress prices". Table 7 shows the changes in price projections of speciality crops for the Westside estimated by Dean and King [3] based on the "excess acreages" shown in Table 6. In order to assess the price depressing effects of excess acreage and production set forth in the water districts' plans, each crop category was analyzed separately with respect to its percent of excess supply relative to the relevant total U.S. market and the price elasticity of demand. Dividing the percentage excess supply by the price elasticity provides an estimate of percentage change in price. These lower prices provide an alternative to the basic 1962-68 average price assumption in the study.

Production costs were estimated by crop and water district. A summary of the costs is available in Appendix Tables A-5 through A-7. The production costs, together with product prices and yields, provide the data on which discounted net returns by crop, time period, and district were calculated.

A Summary of the Alternative Models

To summarize the framework for analysis, three different basic models will be considered. Model I uses the districts' intended cropping plans as

TABLE 7

Estimated Percentage Changes in Prices and Gross Returns for Selected Commodities, Based on Estimated Price Elasticities of Demand and Allocation of "Excess Supply" Based on Judgment Considering Recent Trends

Crop category	Estimated price elasticity of demand	Percentage of excess supply	Percentage change in price	Percentage change in gross return to industry
		percent		
Fruits, nuts, and grapes				
Deciduous fruits	-0.65	4.6	-7.1	-2.8
Tree nuts	-1.31	6.6	-5.0	1.3
Grapes	-0.23	4.0	-17.4	-14.1
Oranges	-0.66	2.3	-7.1[a]	-4.9[a]
Vegetables				
Cantaloupes	-0.50	4.9	-9.8	-5.4
Other vegetables	-0.35	2.3	-6.6	-4.5
Potatoes, early spring	-0.31	13.3	-42.9	-35.3
Other vegetables & potatoes	--	--	-13.2[b]	-9.38[b]

a/ Dean and King assumed price reductions based on fresh market sales only, whereas in this study larger portions are assumed to be allocated to the processing outlet.

b/ Weighted averages of other vegetables and potatoes.

Source: Dean and King [3] p. 109, Table 27.

defined previously. Two separate commodity price conditions are considered. Model IA assumes commodity prices at "constant" (1962-68 average) levels. Model IB assumes the lower set of "depressed" speciality crop prices which may occur if the Westside plans are implemented and other producing regions in the State also reach their projected acreage of speciality crops.

Model II uses approximately the same anticipated gross acreage of speciality crops as Model I but allocates this acreage among districts on the basis of each district's proportion of high quality soil. Models IIA and IIB employ the "constant" and "depressed" price assumptions, respectively.

Model III is based on reducing the acreage of speciality crops from intended plans by amounts sufficient to maintain "constant" prices.

PROJECTED WESTSIDE DEVELOPMENT AND ECONOMIC ANALYSIS

Within the framework explained in the previous sections, projected cropping systems and water use are developed for the Westside area from 1970 to 1990, for each of the Models I, II, and III. Financial feasibility (repayment capacity versus water cost) is then determined for the models under the two alternative price assumptions.

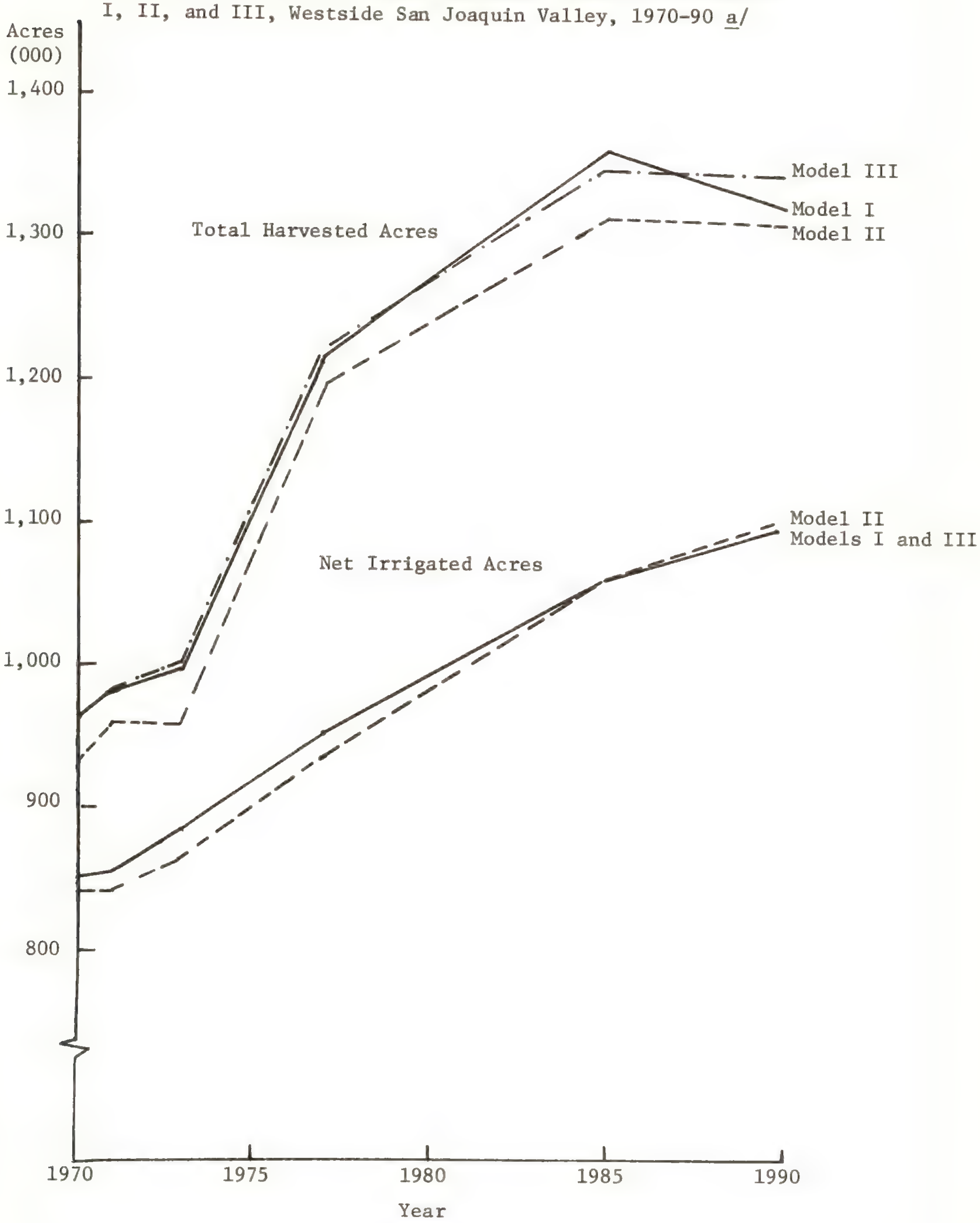
Projected Cropping Patterns and Land Use

A profound shift in the cropping pattern is projected to occur on the Westside under all three Models I, II, and III. As district-owned main canals and laterals are constructed and water is made available at farm headgates, a rapid increase in the net irrigated acreage is projected in all of the planning models. The most rapid increase in irrigated land and harvested acreage is expected to occur in the early part of the development period, 1970 to 1980 (Figure 3). The rate of development is expected to slow in the decade of the 1980's and be completed by 1990, when all district distribution systems should be completed. At completion, net irrigated land will increase by approximately 31 percent over the 1970 acreage.

Since there is a substantial increase in crop intensification, including double-cropping of field crops and vegetables, the increase in harvested acres is much greater than the increase in irrigated land (Figure 3). Total harvested acres increase fastest in the period 1975 to 1979 for all models. This rapid increase reflects two separate effects: (1) the "new land" effect as

FIGURE 3

Total Net Irrigated and Total Harvested Acres Under Models I, II, and III, Westside San Joaquin Valley, 1970-90 a/



a/ Linear interpolations are made between LP solution time blocks, 1971, 1972-74, 1975-79, 1980-89, and 1990+.

shown by the increase in irrigated land, and (2) the "intensification" effect caused by increasing the water supply to existing land (mainly in portions of Westlands Water District).

Harvested acres reach a maximum in the 1980-89 time block and then decline slightly by 1990 (Figure 3). This reduction toward the end of the planning period is caused by a rapid increase in the planted acreage of perennial crops, replacing field crop production which includes a substantial percentage of double cropping.

Total harvested acres for each model are broken down into major crop categories in Figure 4 and Table 8. (See Isyar [5] for more detail, by individual crop.) All three crop categories -- field crops, vegetables, and trees and vines -- show an absolute increase with respect to harvested acreage during the planning horizon. The most dramatic increase occurs in trees and vines, due to the very small acreage planted to trees and vines prior to the project. Vegetables also show a somewhat less dramatic increase, both relatively and in absolute terms.

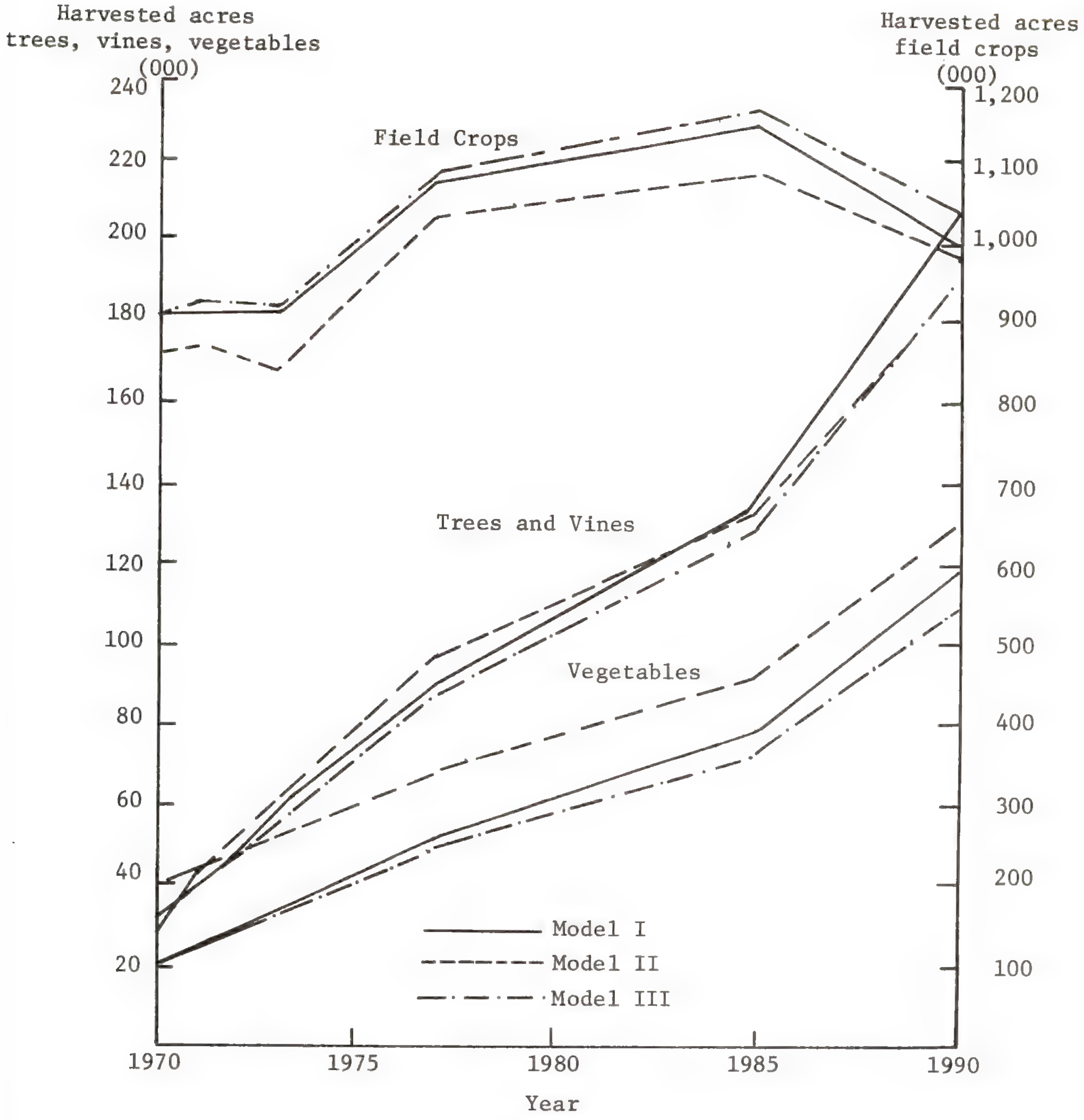
Table 9 shows a breakdown of irrigated land use into field crops, vegetables, and trees and vines, along with total harvested acreage. Total speciality crops (vegetables plus trees and vines) covered only 4 percent of the net irrigated land on the Westside in the preproject period (1968) but increase to 27.5 percent under Model I, 26.5 percent under Model II, and 25.3 percent under Model III by 1990.

Data in Table 9 indicate that the proportion of irrigated land planted to field crops is expected to decline over the planning horizon. Even the absolute acreage of irrigated land in field crops drops between the 1980-89 and 1990+ time blocks. Approximately 94 percent of the irrigated land is allocated to field crops in the first years of the planning model. This decreases to about 73 percent by 1990 under the various models.

The intensity of cropping (measured by harvested acres as a percent of irrigated acres) is expected to increase over the planning period as additional firm water supply to the project area brings an increase in double cropping. Table 9 indicates that land use intensity will increase from about 113 percent in 1970 to about 120 percent by 1990.

FIGURE 4

Total Harvested Acreage by Crop Category and Model, Westside San Joaquin Valley, 1970-90 a/



a/ Linear interpolations are made between LP solution time blocks, 1971, 1972-74, 1975-79, 1980-89, and 1990+.

TABLE 8

Harvested Acreage by Model, Westside San Joaquin Valley, 1970-1990

Model	Activity	1970	1971	1972-74	1975-79	1980-89	1990+
		acres					
Model I	Field crops	905,670	913,969	905,476	1,071,965	1,143,532	991,659
	Vegetables	22,055	25,770	33,367	52,332	77,807	118,770
	Trees & vines	31,965	39,550	57,922	90,446	135,958	207,916
	Total	959,690	979,289	996,765	1,214,743	1,357,297	1,318,345
Model II	Field crops	861,462	870,376	845,243	1,030,010	1,085,368	987,265
	Vegetables	41,069	44,952	52,775	68,605	92,844	129,252
	Trees & vines	29,458	42,381	60,483	97,053	133,548	189,069
	Total	931,989	957,709	958,501	1,195,668	1,311,760	1,305,586
Model III	Field crops	906,302	915,065	910,350	1,081,089	1,165,266	1,040,941
	Vegetables	21,893	25,497	32,783	50,558	73,504	108,817
	Trees & vines	31,78	39,131	56,908	87,380	128,437	190,493
	Total	959,933	979,693	1,000,041	1,219,027	1,346,559	1,340,251

TABLE 9

Irrigated Land Use by Model, Westside San Joaquin Valley, 1970-90

Model	Activity	1970		1971		1972-74		1975-79		1980-89		1990+	
		ac.	pct.	ac.	pct.	ac.	pct.	ac.	pct.	ac.	pct.	ac.	pct.
Model I	Field crops	804,438	94.6	799,415	93.6	796,069	90.2	814,304	85.6	860,430	81.5	793,632	72.5
	Vegetables	13,615	1.6	15,640	1.8	29,026	3.3	46,311	4.9	59,888	5.7	93,654	8.5
	Trees & vines	31,965	3.8	39,550	4.6	57,922	6.5	90,446	9.5	135,958	12.8	207,916	19.0
	Irrigated land	850,018	100.0	854,605	100.0	883,017	100.0	951,061	100.0	1,056,276	100.0	1,095,202	100.0
	Harvested acres	959,690	112.9	979,289	114.6	996,765	112.9	1,214,743	127.7	1,357,297	128.5	1,318,345	120.4
Model II	Field crops	785,322	93.6	772,793	91.9	760,308	88.0	773,890	82.8	833,871	78.8	807,529	73.5
	Vegetables	24,003	2.9	25,861	3.1	43,379	5.0	64,139	6.8	91,564	8.6	101,663	9.5
	Trees & vines	29,458	3.5	42,381	5.0	60,483	7.0	97,053	10.4	133,548	12.6	189,069	17.2
	Irrigated land	838,783	100.0	841,035	100.0	864,170	100.0	935,082	100.0	1,058,983	100.0	1,098,261	100.0
	Harvested acres	931,989	111.1	957,709	113.9	958,501	110.9	1,195,668	127.9	1,311,760	123.9	1,305,586	118.9
Model III	Field crops	804,754	94.7	799,963	93.6	797,564	90.3	817,866	86.1	871,297	82.5	818,272	74.7
	Vegetables	13,526	1.6	15,511	1.8	28,545	3.2	44,815	4.7	56,542	5.3	86,437	7.9
	Trees & vines	31,738	3.7	39,131	4.6	56,908	6.5	87,380	9.2	128,437	12.2	190,493	17.4
	Irrigated land	850,018	100.0	854,605	100.0	883,017	100.1	951,061	100.0	1,056,276	100.0	1,095,202	100.0
	Harvested acres	959,933	112.9	979,693	114.6	1,000,041	113.2	1,219,027	128.2	1,346,559	127.5	1,340,251	122.4

Projected Water Use

Prior to the arrival of project water to the study area in 1968, the existing agriculture was completely dependent on ground water pumping and surface water from minor streams flowing into the area. The sum total of these various sources was estimated at 1,789,000 acre-feet annually (Table 2). Figure 5 and Table 10 show projected water used from 1970 to 1990. At completion of all of the distribution systems in the area (1990), total water use will reach about 3,300,000 acre-feet annually. The project is projected to provide about 70 percent of the total water supply with about 30 percent coming from ground water and minor surface sources.

At full development (1990), ground water pumpage in all models has been limited to the safe yield of the underground basins as estimated by the irrigation districts. Due to this limitation, non-project water use will decline about 39 percent over the planning period, i.e., from about 1,635,000 acre-feet in 1970 down to about 1,000,000 acre-feet in 1990 (Figure 5 and Table 10).

Only a very small proportion of the project water supply (about 1 percent) will go unused at the full development stage. A much higher proportion (17 - 23 percent) of the ground water will go unused under the various models.

Almost all of the unused project water is found in only one district, Wheeler Ridge-Maricopa Water Storage District in Kern County. This district is divided into an ultimate project water area and an ultimate ground water area. Presently there are no plans to construct a distribution system in the ground water area that could transfer excess project water to the ground water area. Therefore, the excess project water (about 33,000 acre-feet under Models I and III and 42,800 acre-feet for Model II at full development) is left unused. It is possible, of course, that this excess water may be sold to other districts.

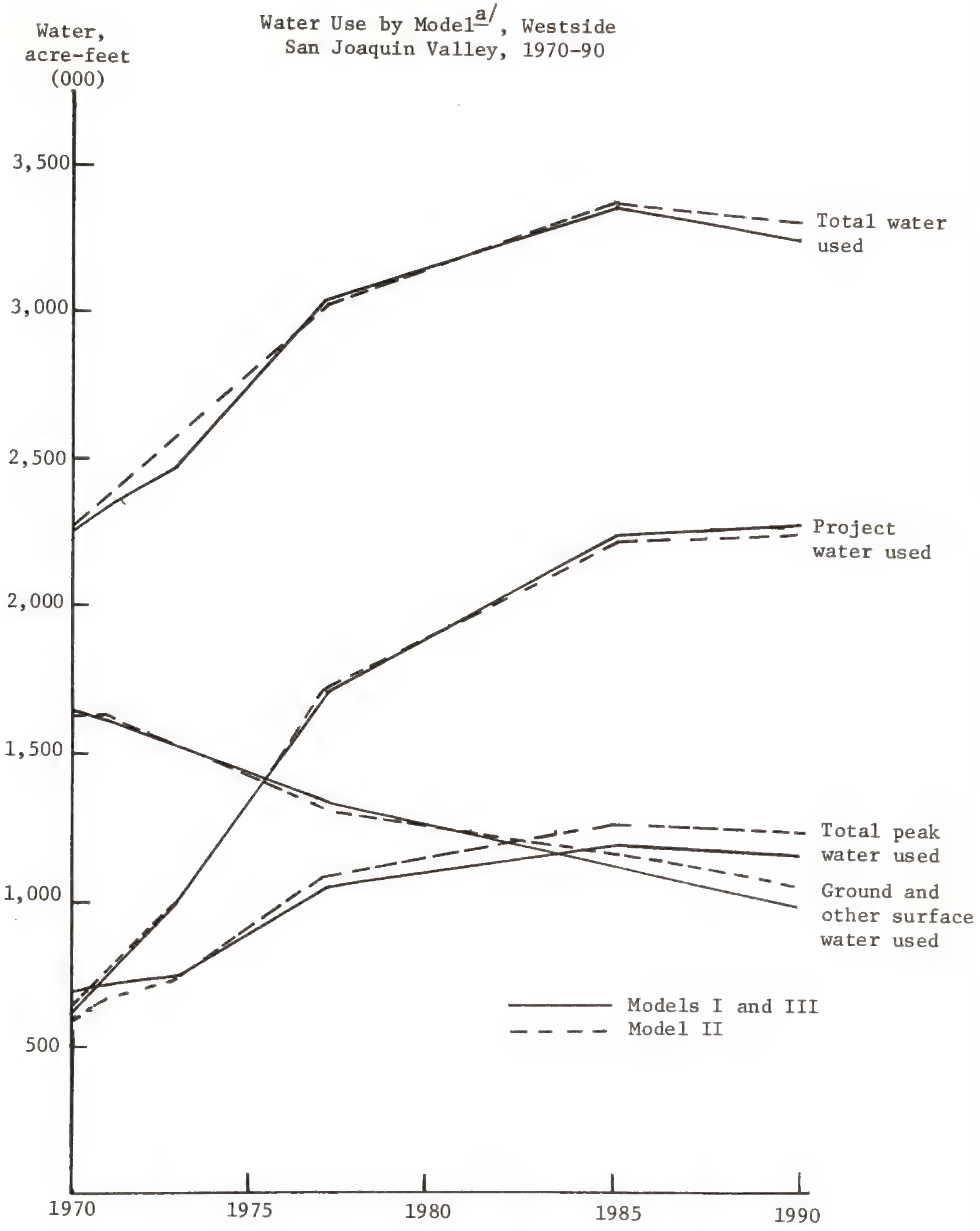
As would be expected, the pattern of total water utilization over the development period is almost identical with the pattern of total harvested acres, reflecting the effect of new land coming under production and intensification on those lands already developed.

Irrigable Lands Left Undeveloped and Unplanted

All of the lands in the service area of the project will not be developed immediately upon water being made available. Even at full development, about

FIGURE 5

Water Use by Model[a/], Westside San Joaquin Valley, 1970-90



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a/ Water use by Models I and III are identical.

TABLE 10

Water Use by Planning Model, Westside San Joaquin Valley, 1970 - 1990 (Acre-feet)

Model	Source of water	Year					
		1970	1971	1972-74	1975-79	1980-89	1990+
Models I and III	Project water used	611,228	723,169	1,004,509	1,699,062	2,245,769	2,277,589
	Project water unused	12,172	42,931	13,691	21,872	13,831	33,256
	Nonproject water used	1,640,067	1,612,187	1,528,596	1,345,917	1,115,657	969,032
	Nonproject water unused	47,677	45,923	65,285	79,151	174,221	284,103
	Total water used	2,251,295	2,335,363	2,484,466	3,044,979	3,361,426	3,246,621
Model II	Project water used	622,892	732,128	1,009,706	1,711,671	2,231,334	2,251,755
	Project water unused	508	33,972	8,494	14,329	28,266	42,845
	Nonproject water used	1,630,605	1,628,960	1,509,543	1,312,323	1,140,726	1,044,131
	Nonproject water unused	57,755	29,147	94,042	113,171	148,815	209,004
	Total water used	2,253,646	2,361,460	2,519,271	3,024,075	3,372,030	3,295,886

12 percent of all irrigable land is left undeveloped. Depending upon the mix of various quality soils in the individual districts, there are noticeable differences between the district's intended cropping plans (Model I) and the district's proportion of high-quality soils suitable for speciality crop production. Consequently, the speed of development of individual soil groups differs under the alternative models. Figure 6 shows that most of this undeveloped land is in the poorest class D soil category which, by definition, is marginal soil requiring extensive reclamation before even highly tolerant field crops can be grown. Class D soils going unplanted show a continuous increase over the planning period. The reader should keep in mind that a parcel of land is not included in the unplanted category until after a water supply has been made available and it still remains unplanted.

Class C soils (Figure 6) indicate an increase in the unplanted category up until the 1975-79 time block and a continuous decrease thereafter. Most of these unplanted C soils are leached and improved to the quality of B soil in the later time blocks.

A and B class soils form a minor part of the total unplanted soils on the Westside. The most important reason for the soils going unplanted after a water supply is made available is the lag in the build-up of market demand for speciality crops best suited for these soils. Secondly, the water supply entitlement is sometimes not sufficient to allow the intensity of cultivation necessary for the economic feasibility of developing these lands.

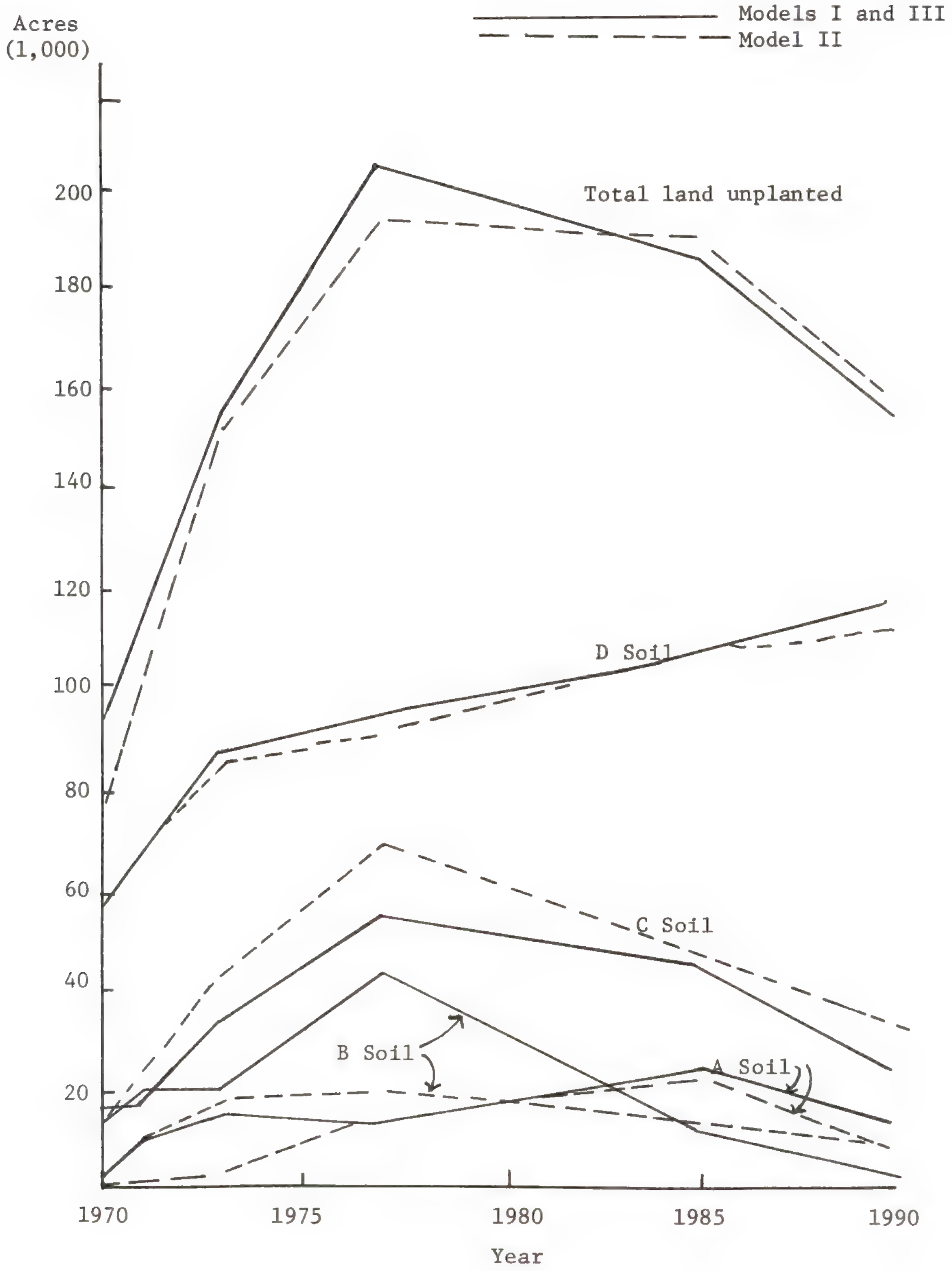
Financial Analysis

Financial analysis for an irrigation project is based on irrigation users' "ability to pay" for water in relation to actual water costs. "Ability to pay" for water, or "repayment capacity" is defined as the residual income remaining to the irrigation user after all costs other than water have been paid or accounted for. U.S. Bureau of Reclamation procedures consider that a project is financially feasible if repayment capacity exceeds actual water costs by some "safe" margin, usually 25 percent. The California Department of Water Resources procedures do not use this "safety" margin.

Water prices to irrigation users are determined by each irrigation district, based on the cost to the district of water from the California Aqueduct and the district's costs for distribution facilities. Based on projected demand for water in the district, the water prices are set at a level

FIGURE 6

Unplanted Land by Soil Categories, by Model, Westside San Joaquin Valley, 1970-90



to cover district costs. District water prices charged to users typically differ by year and by subarea within the same district. Often a large portion of the total price is charged in the form of a fixed assessment per acre of irrigable land in order to encourage immediate development and to insure that projected water demands are met.

Since water charges and quantities used are not constant over the planning period, and since repayment capacity also varies according to the stage of development, these measures are put on a common basis by discounting at 7 percent to obtain present values. For ease in presentation, both repayment capacity and water costs are presented on an acre-foot per year basis, first by expressing the lump sum present values as level payment annuities and then dividing by acre-feet of water used at full development. Water rates and payment capacities per acre-foot obtained on this basis will appear much lower than the actual water charges or repayment capacity per acre in a particular year. However, the relationship between water charges and repayment capacity is the major concern and is accurately represented by this procedure, whereas a direct comparison of water costs and repayment capacity in any particular year could be misleading.

To obtain the project water repayment capacity, an imputed charge for management and a land interest charge must be deducted as well as all other costs except the cost of project water to farm headgates. The management charge was calculated as 15 percent of net income (where net income is defined as total revenue minus all costs except water costs and land interest).[7/] The land interest charge (at 7 percent) was calculated based on estimates of current market values for leveled land. These estimates (Table 11) indicate a 1970 value ranging from $1,000 per acre for class A soil down to $200 per acre for class D soil. Table 11 also shows the present value of these same soils if they are not developed until a future time period. For example, a parcel of class A soil land that will not be developed until 1985 has a present value of only $362 per acre. Or from another point of view, $362 compounded at an interest rate of 7 percent will equal $1,000 after 15 years.

In the repayment capacity-water cost comparisons given in the following section, the major emphasis is on the aggregate Westside situation. Although

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[7/] This procedure differs from that used by federal and State agencies, which generally calculate management as a smaller percentage of gross income. The two procedures ordinarily provide similar management changes.

TABLE 11

Estimated Land Values by Soil Categories and Time Period of Development[a], 7 Percent Interest Rate

Soil categories	Land developed and planted in:					
	1970	1971	1972-74	1975-79	1980-89	1990+
	dollars per acre					
A	1,000	935	816	623	362	258
B	800	748	653	498	290	207
C	500	467	408	311	181	129
D	200	187	163	125	72	52

[a] Land values for land developed after 1970 represent present values. For example, A soil developed in 1990 is valued at $\$258 = \$1,000 \div (1.07)^{20}$.

Source: The first column (land values by soil category in 1970) was obtained based on discussion with the California Department of Highways, Fresno.

this aggregate is built up from individual district data, the reliability of the estimates for individual districts is undoubtedly quite low because of the extreme difficulty of forecasting developments in a restricted geographic area. Though district cropping plans were formulated by private or public agencies in the planning and evaluation stages of the project, these plans are in no way binding on individual growers. The actual developments in any particular locality will depend not only on soils, climate, water costs, and other physical characteristics, but on the size, preferences, capital position, and initiative of individual growers. The decisions of a few large growers to sign contracts for vegetable or wine grape production, to construct processing facilities, etc. could change actual developments in individual districts quite drastically from the published district plans, and markedly change the repayment ability-cost relationships in particular districts. For this reason, the financial results in the following section refer to the entire Westside under some alternative plausible aggregate developments. To provide an idea of the possible variability of financial results within the area, the results also are presented for each of the 13 district units. However, the districts are not specified by name in order to prevent misinterpretation of these micro results.

Results for Model I

Model I includes the same total acreage of speciality crops as specified by district plans. The remaining acreage is allocated to field crops so as to maximize payment capacity for water. An interest or discount rate of 7 percent was used to calculate the present value of future streams of payment capacities and water costs.

Financial results pertaining to Model I are found in Table 12. Model IA assumes commodity prices at "constant" (1962-68 average) levels, while Model IB assumes the lower set of "depressed" speciality crop prices shown earlier in Table 4. Project water repayment capacities are expressed in Table 12 on a per acre and per acre-foot basis for the entire project area. The present value of payment capacity per acre-foot in columns 2 and 4 can be compared directly with the present value of water cost per acre-foot shown in column 5. The ratio of project water repayment capacity to project water cost is presented in columns 6 and 7.

TABLE 12

Project Water Payment Capacity with Project Water Cost by District and Whole Westside Area Under Model I with Constant (Model IA) Prices and Depressed (Model IB) Prices for Specialty Crops a/

(7 percent interest rate)

District b/	Project water payment capacity				Project water costs	Ratio of project water payment capacity to project water cost	
	Constant prices (Model IA)		Depressed prices (Model IB)			Constant prices	Depressed prices
	$/acre	$/acre-foot	$/acre	$/acre-foot	$/acre-foot	(Model IA)	(Model IB)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A	24.68	10.43	15.94	6.73	10.37	1.01	0.65
B	62.95	21.21	38.87	13.09	16.47	1.29	0.79
C	52.01	18.99	40.46	14.77	20.41	0.93	0.72
D	33.41	30.90	32.90	30.44	9.36	3.30	3.25
E	65.96	24.83	32.63	12.28	25.20	0.99	0.49
F	24.23	13.30	22.48	12.19	15.93	0.84	0.77
G	19.36	11.97	17.62	10.89	12.34	0.97	0.88
H	1.02	1.28	0.87	1.09	11.85	0.10	0.09
I	23.60	15.73	23.60	15.73	16.93	0.93	0.93
J	8.20	18.59	8.20	18.59	11.98	1.55	1.55
K	76.93	28.47	43.32	16.03	23.41	1.22	0.68
L	38.46	17.99	30.09	14.07	20.65	0.87	0.68
M	50.57	19.84	42.74	16.77	19.28	1.03	0.87
Total Westside	32.03	15.17	21.20	10.04	14.73	1.03	0.68

a/ All payment capacities and water costs expressed in terms of annual equivalent present values. Thus, the values are significantly lower than actual dollar values of payment capacities and water costs in a particular year.

b/ Districts labeled randomly.

Under the assumption that the irrigation districts will implement their planting intentions and speciality crop prices will remain constant (Model IA, column 6), the overall project repayment capacity will just cover overall project water costs. That is, the ratio of repayment capacity to water cost is slightly greater than unity (1.03). A wide variation appears, however, among districts -- the ratio ranging from 3.30 down to as low as 0.10.

If, however, the projections of future demand for California speciality crop production made by Dean and King [3] are more nearly correct and all of the irrigation districts implement their intended planting plans, "depressed prices" and lower repayment capacities would result. The results of this assumption are summarized under Model IB (column 7, Table 12). The effects of depressed prices on overall project repayment capacity are rather drastic, resulting in a repayment capacity to water cost ratio of 0.68 -- significantly below the breakeven ratio of 1.0.

Under the assumption of depressed prices (Model IB), all but two districts are worse off financially than under the constant price assumption. (These two districts included no speciality crops in their plans.) In general, those districts with a high proportion of speciality crops in their planting intentions reflect the impact of depressed prices more than those districts who were more conservative with respect to planned acreage of speciality crops.

Due to the extended planning horizon, present value calculations of net incomes are very sensitive to the discount rate. The data in Table 13 show a significant improvement when the discount rate is reduced by only 2 percentage points from 7 to 5 percent. At the lower discount rate, the ratio of project water repayment capacity to water costs approximately doubles for the westside area as a whole, increasing from 1.03 to 2.07 under the assumption of constant prices. Even under the assumption of depressed speciality crop prices, the repayment capacity-water cost ratio increases from 0.68 to 1.65 -- well above the breakeven ratio of unity. Under the 5 percent discount rate, no district falls below the breakeven level under either price assumption. Thus, if irrigation users can borrow at lower rates or if they invest their own capital and are willing to accept lower than market rates of return, the financial feasibility of the project is much improved. Of course, a 5 percent discount rate is well below the current commercial market rate of interest, even though it approximates the discount rate used in recent years by Federal agencies in evaluating the economic feasibility of water development projects.

TABLE 13

Project Water Payment Capacity and Project Water Cost by District and Whole Westside Area Under Model I with Constant and Depressed Prices for Specialty Crops a/

(5 percent interest rate)

District b/	Project water payment capacity				Project water costs	Ratio of project water payment capacity to project water cost	
	Constant prices (Model IA)		Depressed prices (Model IB)			Constant prices (Model IA)	Depressed prices (Model IB)
	$/acre	$/acre-foot	$/acre	$/acre-foot	$/acre-foot		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A	55.95	23.64	44.80	18.93	9.96	2.37	1.90
B	95.69	32.24	66.02	22.24	15.35	2.10	1.45
C	81.72	29.84	67.44	24.63	19.13	1.56	1.29
D	50.39	46.61	49.86	46.12	8.79	5.30	5.26
E	103.12	38.81	75.49	28.41	24.10	1.61	1.18
F	46.10	25.00	43.83	23.77	14.97	1.67	1.58
G	41.41	25.60	39.65	24.51	11.91	2.15	2.06
H	19.81	24.85	19.23	24.13	10.93	2.27	2.21
I	48.47	32.31	48.47	32.31	15.17	2.13	2.13
J	36.14	81.93	36.14	81.93	10.63	6.84	7.71
K	125.38	46.41	80.32	29.73	22.42	2.07	1.33
L	69.20	32.36	57.57	26.92	18.92	1.71	1.42
M	74.41	29.19	64.71	25.38	17.91	1.63	1.41
Total Westside	61.06	28.92	48.77	23.02	13.96	2.07	1.65

a/ All payment capacities and water costs expressed in terms of annual equivalent present values. Thus, the values are significantly lower than actual dollar values of payment capacities and water costs in a particular year.

b/ Districts labeled randomly.

Results for Model II

Model II includes approximately the same total speciality crop acreage as Model I but reallocates it among districts proportionate to the acreage of high-quality soil in each district. Financial analysis indicates that very little change takes place in aggregate repayment capacity compared with Model I but that significant changes occur in individual districts. The data in Table 14 show that under Model IIA (constant prices) the overall Westside repayment capacity increases about 3 percent compared with Model I while repayment capacity under Model IIB (depressed prices) declines by about 1 percent. The repayment capacity-water cost ratio is slightly greater than the breakeven ratio under Model IIA (1.03) but is well below the breakeven level ratio under Model IIB (0.67).

Reallocation of the speciality crop acreage among districts on the basis of soil capability improves the repayment capacity-water cost ratio for 9 of the 13 irrigation districts while reducing it for the other 4 districts under the constant price assumption (Model IIA compared with Model IA). By reducing the speciality crop acreage in the districts with optimistic plans and increasing it in the districts with more conservative plans, the position of the poorest 3 districts is improved, and there is an increase in the number of districts from 6 to 7 which have a ratio greater than 1.00.

For Model IIB (depressed prices), 6 districts have lower repayment capacity-water cost ratios than if they had followed their original plans while 5 are better off and 2 remained unchanged (Model IIB compared with Model IB). Lowering the discount rate to 5 percent would significantly improve repayment capacity as was the case for Model I.

Results of Model III

Under Model III, speciality crop acreage throughout the State is reduced sufficiently to maintain constant (1962-68 average) prices. A detailed district by district analysis was not made for Model III; rather the cropping pattern for Model I for each district was taken as given. Then the speciality crop acreage in each district was decreased by the proportionate amount necessary to maintain prices, based on the estimates of Dean and King [3]. Feed grain acreage (wheat-milo double-cropped) was substituted for the speciality crop acreage eliminated. The calculations of percentage acreage reductions in speciality crops are shown in Table 6. For example, at full development (1990+), total speciality crop acreage in each district would be 8.3 percent less than in Model I.

TABLE 14

Project Water Payment Capacity and Project Water Cost by District and Whole Westside Area Under Model II with Constant and Depressed Prices for Specialty Crops a/

(7 percent interest rate)

District[b]	Project water payment capacity				Project water costs	Ratio of project water payment capacity to project water cost	
	Constant prices (Model IIA)		Depressed prices (Model IIB)			Constant prices	Depressed prices
	$/acre	$/acre-foot	$/acre	$/acre-foot	$/acre-foot	(Model IIA)	(Model IIB)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A	29.40	12.42	16.03	6.77	10.37	1.20	0.65
B	50.64	14.56	41.42	11.91	16.37	0.89	0.73
C	51.88	18.96	35.54	12.99	19.68	0.96	0.66
D	35.06	36.40	25.37	26.34	9.36	3.89	2.81
E	58.77	21.05	33.37	11.95	23.73	0.89	0.50
F	32.13	18.15	23.29	13.16	15.93	1.14	0.83
G	23.44	16.06	19.53	13.38	12.34	1.30	1.08
H	3.50	4.39	2.43	3.04	11.85	0.37	0.26
I	31.90	21.26	23.55	15.70	16.93	1.25	0.93
J	9.49	21.51	7.06	16.01	11.98	1.79	1.34
K	47.43	18.83	30.61	12.15	24.00	0.78	0.51
L	46.87	21.92	30.56	14.30	20.65	1.06	0.69
M	39.51	17.95	29.48	13.40	19.28	0.93	0.70
Total Westside	32.22	15.88	20.24	9.66	14.44	1.06	0.67

a/ All payment capacities and water costs expressed in terms of annual equivalent present values. Thus, the values are significantly lower than actual dollar values of payment capacities and water costs in a particular year.

b/ Districts labeled randomly.

Under the assumptions of Model III, the repayment capacity for the entire Westside service area is \$27.66 per acre or \$13.11 per acre-foot using a discount rate of 7 percent. The present value water cost is \$14.73 per acre-foot and the ratio of repayment capacity to project water cost is 0.89. That is, Models I and II indicated that if growers carry out their present planting intentions and speciality crop prices are depressed, the repayment capacity-water cost ratio will also be depressed to 0.67-0.68, compared to 0.89 under Model III. The implication of these results is that if the Dean-King analysis of demand and supply is correct, producers would be considerably better off to reduce production in order to maintain constant prices rather than to overproduce and suffer the commensurate depressed prices.

CONCLUSIONS AND RECOMMENDATIONS

Taking the Westside as an aggregate, the analyses in this report indicate that bringing a new water supply to the Westside is a viable undertaking from the point of view of financial repayment so long as (1) speciality crop production in the State does not reach levels which depress prices significantly, (2) some reallocation of speciality crops among districts is made in order to bring payment capacity in each district more into line with water costs without increasing the aggregate speciality crop acreage. Emphasis in this report is on aggregate financial feasibility for the Westside area rather than on financial feasibility for each district individually. However, financial results vary from area to area and districts and individual growers would be well advised to carefully recheck cropping plans for financial viability under alternative price conditions.

The term "financial feasibility" should not be interpreted too literally. A ratio of payment capacity to water cost less than 1.0 does not necessarily imply bankruptcy for a district or the firms in it. First, the firms operating in the district may have sufficient capital resources to pay water costs even if added income does not completely cover costs. Second, if payment capacity is lower than water costs, it is likely that land prices would adjust downward to reflect the lower levels of earnings. For example, under Model IB (district cropping plans, depressed prices), land prices would need to drop by about 38 percent for the Westside in the aggregate in order to bring payment capacity for water up to equality with water costs. Thus, land owners would likely absorb much of the impact of lowered payment capacities. Third, it is possible that the production costs, yields, and net returns used in this study may be too pessimistic and that actual payment capacity may exceed our estimates. Fourth, the market and price implications of overproduction of speciality crops based on the projections of Dean and King [3] may be too drastic.

Still, the unmistakable thrust of the results of this study is that the Westside development may bring on severe financial difficulties for some districts on the Westside, and that the spillover effects in terms of lower prices elsewhere in the State may create income problems in other areas producing speciality crops. If these projections are reasonably on target, what steps could be taken to alleviate the problems? Several possibilities, none of them novel, come to mind. The pros and cons of each are briefly considered below.

One method of attempting to raise prices (and therefore payment capacity), is by controlling acreage and production of speciality crops through marketing orders or quotas. In a state as large and diverse as California, this step would face many practical difficulties, as experience with some individual commodities has shown. Many of the speciality crops contemplated for production on the Westside are already under State or Federal marketing orders. The imposition of production quotas has been, in general, based on production history and new producing areas would have difficulties obtaining adequate shares of the market quotas. From an equity point of view, this procedure is also questionable since it provides existing growers with a quasi-monopoly and precludes production in a new producing area even if the new area has a net comparative advantage. Secondly, a marketing order would prove effective only if it covered all speciality crops. If this condition were not met, the ability of growers to shift resources from controlled to uncontrolled crops could defeat the objectives of the program by depressing the prices of the uncontrolled commodities. It is doubtful, therefore, that the general answer to problems created by overproduction is more marketing orders.

Another obvious alternative for increasing project financial feasibility is to reduce water costs. By reducing water costs in the State service areas (e.g., through interest-free loans to build distribution systems and drainage facilities such as used in the Federal service areas), financial feasibility could be markedly improved. This approach also has limitations with respect to political acceptability and economic efficiency. From a political standpoint, the voters of the State were assured, when they approved the issuance of State general obligation bonds to build the storage and aqueduct system, that State water users and beneficiaries would repay all reimbursable project costs. For interest-free loans or other forms of subsidy to be granted after the fact would be considered by many to be a breach of contract. A subsidy to any class of water users which operated to the detriment of existing producers (e.g., by depressing commodity prices), would raise difficult equity and efficiency questions.

A more optimistic outcome would be that producers will react in rational economic fashion by voluntarily reducing plantings more in line with market conditions. This study indicates that if all California producers respond to the threat of lower prices (or to actual lower prices in particular years) by reducing acreages sufficiently to maintain recent prices, then repayment capacity on the Westside will still be less than water costs but would be greater than if intended plans were carried out and prices became depressed. It should be emphasized that the required producer response is not just a "Westside problem". Producers on the Westside alone could not reduce planned speciality crop acreages sufficiently to raise prices significantly without impairing financial feasibility still further. In this case, the total speciality crop acreage on the Westside would be so small that repayment capacity would be even lower. Thus, producers in all areas of the State must assess markets carefully before planning large-scale acreage increases in trees, vines, and vegetables. Probably the best weapon against overproduction is knowledge of market conditions. It is hoped that this study will be helpful in performing such an informational role.

One final more general inference may be drawn with respect to future large scale inter-river-basin water transfers. Several very large-scale diversions of water have been suggested for California in the future. These include development of the North Coast water supplies, and in the longer run, water transfers from the Pacific Northwest and/or Canada and Alaska to the arid Southwest of the United States. These plans assume that irrigated agriculture will absorb a high percentage of this expensive water within a period of a decade or two. This report has attempted to demonstrate the economic difficulties which may be encountered when the rate of development of land is faster than the rate of build-up of market demand for high-value speciality crops. The magnitude of this problem is in direct relation to the scale of the anticipated interregional transfer. That is, the possible price depressing effects of the rapid addition of large acreages of speciality crops may preclude the feasibility of these large-scale projects. This suggests that methods and technologies of providing additional urban water supplies should be explored as alternatives to more large dams and aqueducts which, because of their large scale, have traditionally relied heavily on the agricultural component for economic and financial feasibility.

APPENDIX: SELECTED BASIC DATA

APPENDIX TABLE A-1

Field Crops and Vegetables: Yields Selected for Analysis, Westlands W.D., a/ Fresno County

Crops	Unit	Yield per acre			
		A Soil	B Soil	C Soil	D Soil
Field Crops:					
Sugar beets	tons	26.50	26.50	26.50	19.875
Dry beans	tons	1.50			
Alfalfa seed	pounds	670	670	603	
Cotton	lb. lint	1,375	1,375	1,238	
Field corn	tons	3.25	3.25	2.925	
Barley	tons	2.00	2.00	1.80	1.50
Wheat	tons	2.00	2.00	1.80	1.50
Grain sorghum	tons	3.00	3.00	2.70	2.25
Vegetables:					
Processing tomatoes	tons	26.00	23.40		
Cantaloupes b/	tons	12.00	10.80		
Other vegetables c/					

a/ Sources: Fresno County Agricultural Director; Report on the Westlands Water District, 1968; Potential Development of The Berrenda Mesa Water District by Carter, Dean, Ferry [1].

b/ A 10 percent yield reduction is assumed for Fall cantaloupes and other Fall vegetables.

c/ Yields for vegetables comprising Spring, Fall, and double-cropped categories not shown individually.

APPENDIX TABLE A-2

Field Crops and Vegetables: Yields Selected for Analysis, by Soil Type, for Districts in Kern County a/

Crops	Unit	Yield per acre			
		A Soil	B Soil	C Soil	D Soil
Field Crops:					
Sugar beets	tons	25.00	25.00	22.50	19.00
Dry beans	tons	1.50			
Alfalfa seed	pounds	600	600	540	
Cotton	lb. lint	1,375	1,375	1,238	
Field corn	tons	3.00	3.00	2.70	
Barley	tons	2.00	2.00	1.80	1.50
Wheat	tons	2.00	2.00	1.80	1.50
Grain sorghum	tons	2.50	2.50	2.25	1.88
Vegetables:					
Processing tomatoes	tons	25.00	22.50		
Cantaloupes b/	tons	12.00	10.80		
Other vegetables c/					

a/ Sources: Kern County Agricultural Director; Kern County Lands Development Company; Potential Development of the Berrenda Mesa Water District by Carter et al. [1].

b/ A 10 percent yield reduction is assumed for Fall cantaloupes and other Fall vegetables.

c/ Yields for vegetables comprising Spring, Fall, and double-cropped categories not shown individually.

APPENDIX TABLE A-3

Fruits, Nuts, and Vines: Yields Selected for Analysis[a/] in Westlands W.D., Kings County, and Kern County

Crops	Unit	Yield per acre by year												Length of life (yrs.)
		3	4	5	6	7	8	9	10	11	12	13	14+	
Almonds	Tons in shell	--	0.16	0.32	0.65	0.86	1.03	1.14	1.19	1.30	1.40	1.40	1.40	35
Walnuts	Tons in shell	--	0.10	0.20	0.30	0.45	0.55	0.70	0.80	0.90	1.00	1.05	1.10	35
Oranges, navels	50-pound field box, on tree	--	25	150	275	360	420	460	480	490	500	500	500	40
Oranges, valencias	50-pound field box, on tree	--	50	220	350	420	470	510	520	530	540	540	540	40
Olives	Tons	--	0.5	1.0	2.0	3.0	3.6	4.1	4.5	4.8	5.0	5.0	5.0	50
Nectarines[b/]	Tons	--	--	1.0	3.0	6.0	7.5	8.0	8.0	8.0	8.0	8.0	8.0	25
Peaches clingstone	Tons	--	4.0	8.9	13.0	15.0	17.0	18.0	18.0	18.0	18.0	18.0	18.0	20
Peaches freestone[c/]	Tons	--	--	1.0	3.0	6.0	7.5	8.5	9.0	9.0	9.0	9.0	9.0	20
Plums[b/]	Tons	--	--	0.66	2.2	4.0	5.0	5.7	6.0	6.0	6.0	6.0	6.0	35
Grapes, wine	Tons	3.0	6.0	8.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	35

a/ Source: Carter, Dean, and Ferry, Potential Development of the Berrenda Mesa Water District, [1], unpublished report, table 14, p. 36.

b/ Salable fruit is only 90 percent of yields shown.

c/ Salable fruit is only 75 percent of yields shown.

NOTE: Wheeler Ridge - Maricopa W.S.D., and Berrenda Mesa W.D. are wind pass areas; therefore, some yield reduction might occur in these districts. However, if wind breaks are built, the yield reducing damage of wind is eliminated.

APPENDIX TABLE A-4

Basic Commodity Prices Selected for Analysis

Crop	Unit	Average price, 1962-68				Projected price per unit		
		State	Kern County	Kings County	Fresno County	Kern County	Kings County	Fresno County
		dollars per unit						
Field Crops								
Sugar beets	tons	14.40	13.40	12.86	12.69	14.50	13.00	13.00
Beans, blackeyes	tons	217.00	174.00	163.80	188.57	200.00	180.00	200.00
Alfalfa seed	pounds	0.39	0.41	0.39	0.40	0.42	0.40	0.42
Cotton a/	pounds	0.31	0.32	0.33	0.32	0.32	0.32	0.32
Field corn	tons	51.00	52.00	52.72	53.80	50.00	52.00	53.00
Barley	tons	40.00	47.00	47.56	47.66	45.00	47.00	47.00
Wheat	tons	40.00	47.00	53.00	51.00	45.00	50.00	50.00
Grain sorghum	tons	44.00	43.50	45.80	44.77	44.00	45.80	45.00
Vegetables								
Processing tomatoes	tons	35.50	38.00	36.00	32.00	26.00	26.00	26.00
Cantaloupes b/	tons	113.40	126.00 d/	145.00 d/	115.00 d/	115.00	115.00	115.00
Other vegetables c/								
Nuts								
Almonds	tons in shell	641.00	682.00 e/	633.00 e/	596.67 e/	600.00	600.00	600.00
Walnuts	tons in shell	474.00	N.A.	478.54	442.86	460.00	460.00	460.00
Fruits								
Oranges, navels f/	cwt.	5.51	N.A.	6.30	6.30	5.00	5.00	5.00
Oranges, valencias f/	cwt.	4.91	N.A.	5.00	5.00	4.00	4.00	4.00
Olives	tons	259.00	N.A.	240.50	270.00	250.00	250.00	250.00
Nectarines	tons	120.00	N.A.	204.43	220.00	200.00	200.00	200.00
Peaches, clingstone	tons	83.00	68.00	74.00	69.00	80.00	80.00	80.00
Peaches, freestone	tons	N.A.	N.A.	N.A.	152.00	150.00	150.00	150.00
Plums	tons	124.00	297.00	242.00	243.00	200.00	200.00	200.00
Vines								
Grapes, wine	tons	61.00	56.00	50.77	57.78	75.00	75.00	75.00

a/ Price in 1970 is $0.32 per pound and declines one cent each year until 1976; remains at $0.26 thereafter.

b/ The prices in all three counties are declining in 1967 and 1968.

c/ Prices for individual vegetables not shown.

d/ Average price, 1966-68.

e/ Average price, 1964-68.

f/ Price to grower for harvested fruit.

APPENDIX TABLE A-5

Summary of Production Costs (Omitting Water Costs, Interest on Land, and Managerial Share) for Field Crops and Vegetables by Soil Categories

Crop	Soil A a/				Soil B		Soil C		Soil D	
	Pre-harvest costs	Harvest costs	Depr. & interest costs	Total costs	Harvest costs	Total costs	Harvest costs	Total costs	Harvest costs	Total costs
	dollars per acre									
Sugar beets	107.23	62.50	22.71	192.44	62.50	192.44	56.25	186.19	46.88	176.82
Dry beans	49.60	56.00	22.76	128.36	--	--	--	--	--	--
Alfalfa seed	113.08	21.18	18.74	153.00	21.18	153.00	21.16	152.98	--	--
Cotton b/	121.98	118.44	27.41	267.83	118.44	267.83	107.13	256.52	--	--
Grain sorghum	56.42	15.00	22.16	93.58	15.00	93.58	14.50	93.08	11.60	90.18
Wheat (or barley)	46.13	14.00	21.06	81.19	14.00	81.19	13.40	80.59	10.72	77.91
Wheat-dry beans	90.73	70.00	22.76	183.49	--	--	--	--	--	--
Wheat-milo	97.55	29.00	22.16	148.71	29.00	148.71	27.90	147.71	22.32	142.03
Processing tomatoes	149.16	251.40	62.82	463.38	226.40	438.38	--	--	--	--
Cantaloupes c/ d/	224.69	600.00	61.72	886.41	540.00	826.41	--	--	--	--

a/ Preharvest costs, depreciation, and interest costs remain constant for all soils.

b/ Allowance is not made for seed value in total costs, instead seed value added to total revenue.

c/ Total costs will be reduced consistent with 10 percent yield reduction for fall crop.

d/ Total costs equal the sum of two total costs minus 50 percent saving in depreciation + interest costs minus 50 percent saving in county land taxes per acre for cantaloupes following cantaloupes.

APPENDIX TABLE A-6

Summary of Production Costs (Omitting Water Costs, Interest on Land, and Managerial Share) for Fruits, Nuts, and Vines, by Year in Kern, Kings, and Fresno Counties, at 7 percent Discount Rate

Crop	Year	Pre-harvest costs	Harvest costs	Depr. + interest costs	Total costs
		dollars per acre			
Tree nuts[a]	1	243.89	--	113.65	357.54
	2	82.97	--	103.65	186.62
	3	105.22	--	104.15	209.37
	4	130.77	54.45	117.65	302.87
	5	194.13	64.05	120.65	378.83
	6	198.53	87.30	121.65	407.48
	7	201.83	99.90	121.65	423.38
	8	207.60	110.10	121.65	439.35
	9	213.10	118.70	121.65	453.45
	10	219.70	121.70	121.65	463.05
	11	225.20	128.30	121.65	475.15
	12+	231.58	134.30	121.65	487.53
Oranges, navels & valencias	1	741.13	--	168.97	910.10
	2	115.56	--	118.97	234.53
	3	91.47	--	116.97	208.44
	4	105.66	27.50	118.97	252.13
	5	174.68	121.00	118.97	414.65
	6	198.88	192.50	118.97	510.35
	7	220.88	231.00	118.97	570.85
	8	224.26	258.50	118.97	601.73
	9	266.26	280.50	118.97	665.73
	10	295.35	286.00	118.97	700.32
	11	295.35	291.50	118.97	705.82
	12+	295.35	297.00	118.97	711.32
Olives	1	123.16	--	43.50	166.66
	2	36.61	--	38.50	75.11
	3	37.82	--	38.50	76.32
	4	48.73	48.15	39.00	135.88
	5	55.61	92.85	39.00	187.46
	6	69.39	182.25	39.50	291.14
	7	124.14	271.65	42.00	437.79
	8	161.92	326.29	42.00	530.21
	9	200.97	371.99	42.00	614.96
	10	200.97	407.75	42.00	650.72
	11	200.97	434.57	42.00	677.54
	12+	200.97	452.45	42.00	695.42
Nectarines	1	195.97	--	76.38	272.35
	2	92.57	--	68.38	160.95
	3	117.87	--	68.38	186.25
	4	138.77	--	69.38	208.15
	5	174.14	33.45	70.38	277.97
	6	220.88	85.45	71.38	377.71
	7	282.98	163.45	72.38	518.81
	8	356.35	202.45	73.38	632.18
	9+	427.63	215.45	77.38	720.46

Footnotes at end of table

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APPENDIX TABLE A-6 (continued)

Crop	Year	Pre-harvest costs	Harvest costs	Depr. + interest costs	Total costs
		dollars per acre			
Peaches, clingstone	1	274.73	--	93.20	367.93
	2	83.16	--	83.20	166.36
	3	152.35	--	84.20	236.55
	4	341.22	71.36	89.20	501.78
	5	364.60	158.78	88.20	611.58
	6	393.75	231.92	87.20	712.87
	7	420.81	267.60	86.20	774.61
	8	452.49	303.28	85.20	840.97
	9+	485.49	321.12	85.20	891.81
Peaches, freestone	1	208.95	--	48.03	256.98
	2	75.96	--	48.03	123.99
	3	102.36	--	49.03	151.39
	4	155.16	--	49.03	204.19
	5	195.58	33.45	49.03	278.06
	6	235.18	85.45	49.03	369.66
	7	319.18	163.45	49.03	531.66
	8	356.46	202.45	49.03	607.94
	9	390.56	228.45	49.03	668.04
	10+	420.45	241.45	50.53	712.44
Plums	1	172.87	--	76.38	249.25
	2	71.67	--	68.38	140.05
	3	107.97	--	68.38	176.35
	4	152.46	--	69.38	221.84
	5	215.38	19.80	70.38	305.56
	6	275.88	66.00	70.38	412.26
	7	335.78	120.00	71.38	527.16
	8	390.70	150.00	71.38	612.08
	9	395.70	171.00	71.38	638.58
	10+	395.70	180.00	71.38	647.08
Grapes, wine	1	149.22	--	70.17	219.39
	2	317.79	--	62.17	379.96
	3	82.75	45.00	63.67	191.42
	4	94.08	90.00	63.67	247.75
	5	100.65	120.00	64.17	284.82
	6+	108.44	135.00	64.67	308.11

a/ Average of almonds and walnuts.

APPENDIX TABLE A-7

Irrigation System Costs

I.	Permanent Set				
A.	Investment	$600	$300 below ground 30 yrs.	Depreciation	$10.00
			Interest 7 %	Interest	10.50
			$300 above ground 15 yrs.	Depreciation	20.00
			Interest 7 %	Interest	10.50
			Maintenance (1/2 sprinkler heads, etc., replaced every four years)	Maintenance	11.00
				TOTAL/acre.	$62.00
B.	Labor	1 man $5,000/year handles 1,000 acres			5.00
				TOTAL/ACRE	$67.00
II.	Solid Set	Same as above.			
III.	Portable System				
A.	Investment		$125 per acre 15 yrs.	Depreciation	$ 8.00
			Interest 7 %	Interest	4.38
				Maintenance	1.00
				TOTAL/acre	$13.38
B.	Labor	$2.50 to move quarter mile line (50' move) 8 irrigations per year			$13.00
			Single crop	TOTAL/ACRE	$26.38
		Double crop (+$13.00)		TOTAL/ACRE	$39.38
IV.	Pull-Hose System				
A.	Investment	$300	$150 underground 30 yrs.	Depreciation	$ 5.00
			Interest 7 %	Interest	5.25
			$150 above ground 10 yrs.	Depreciation	15.00
			Interest 7 %	Interest	5.25
				TOTAL/acre	$30.50
B.	Labor	1 man $5,000/year handles 500 acres			10.00
				TOTAL/ACRE	$40.50

Source: Carter, et al. [1].

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